

UNDERSEAWARFARE

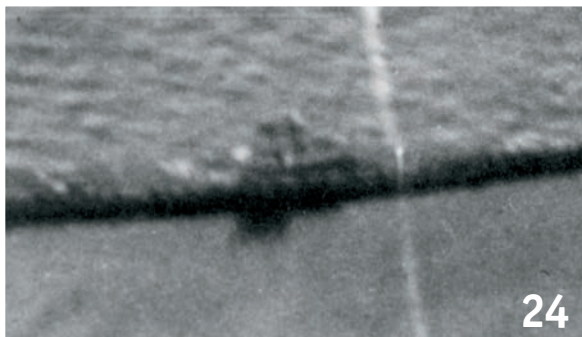
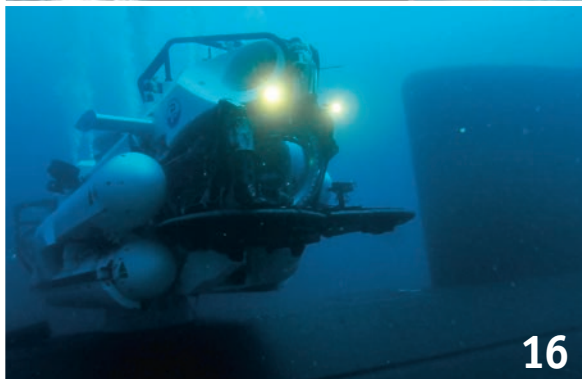
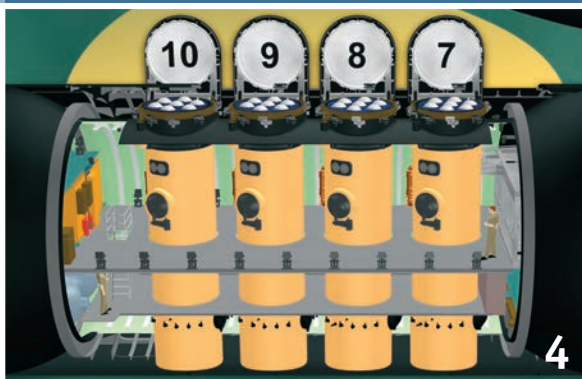
U. S. S U B M A R I N E S... B E C A U S E S T E A L T H M A T T E R S

UNDERSEA PAYLOADS

Keeping the Tip of the Spear Sharp

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The *Virginia* Payload Module
Ensuring Torpedo Reliability
N97 Talks about Tactical Payloads
California Joins the Fleet
Mississippi's Christening



UNDERSEAWARFARE

THE OFFICIAL MAGAZINE OF THE U.S. SUBMARINE FORCE

UNDERSEA PAYLOADS

Keeping the Tip of the Spear Sharp

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The photo of a welder working on a *Virginia* payload tube illustrates the tremendous volume that tubes of this sort offer for current and future payloads.

Photo courtesy of
General Dynamics Electric Boat

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FORCE COMMANDER'S CORNER

"As we celebrate 112 years, looking forward, we're on the leading edge of what I see as the fourth generation of undersea warfare."

Vice Adm. John Richardson, USN,
Commander, Submarine Forces



Team,

On this, our 112th birthday, it's only fitting that we should take some time to be grateful for what we've inherited from our past, and to think about what this means for our future.

Currently, there is no undersea force—indeed, no other maritime power—that can match the U.S. Submarine Force. This superiority has been forged by a history of bravery, creativity and innovation from our early pioneers, our World War II heroes and our Cold War warriors. As we celebrate 112 years, looking forward, we're on the leading edge of what I see as the fourth generation of undersea warfare. Let me explain.

We got started over a century ago, when a few brave and bold men saw opportunity and advantage in the ocean depths. They wanted to explore this domain—to dive beneath the surface and return. Men like David Bushnell and Jules Verne captivated their imagination, and on April 11, 1900, the U.S. Navy purchased what would become USS *Holland*. Our early years as a force saw other brave men expand on this initial effort—diving deeper and going longer. It took decades of fortitude and creativity, but in the late 1930s and early 1940s, the first generation of undersea warfare—our experimental phase—came to a close as the Navy produced fleet boats with the speed, endurance, weapons and payload that would make the submarine a warfighting platform.

And this happened just in time—literally on the dawn of World War II. And we didn't get it all quite right. Our tactics, training, and weapons were built for fleet support—to operate as scouts for the battleships that were the capital ships of the day. It was only after the attack on Pearl Harbor, which virtually eliminated the battle fleet, that we once again had to get creative and adapt on the fly. And once again, it was a few bold visionaries who built a Submarine Force that was to dominate the seas and make a decisive difference in the war.

It was this second generation of undersea warriors—our WWII heroes—that set the high standards of performance that still define our Submarine Force. In those days, less than 10 percent of the students could pass Submarine School. It was demanding, and only the smartest and toughest had what it took to fight the entire boat—to learn not only his job, but the job of other shipmates as well. Submarining was then, and is now, a fight for efficiency: every bit of space was used, and every person on board knew how to fight in every space. Once a person learned how to fight their boat—their whole boat—they would qualify in submarines and wear the dolphins that garnered respect from all who saw them, just like today. And the Force punched way above its weight—penetrating defenses, operating in hostile seas, imposing a tremendous cost on the enemy. Then, as today, the Submarine Force accounted for about 6 percent of Navy personnel. But submarine crews accounted for more than 55 percent of the ships sunk during the war, becoming what the Japanese naval historian Masanori Ito describes as "... the most potent weapon ... in the Pacific War."

The third generation of undersea warfare was defined by the advent and adaptation of nuclear power—in weapons and propulsion. Again, here we see the unbeatable mix of bold, creative people putting advanced technology to use to secure our nation's interests. All of the standards of training and performance established by the warriors of WWII would serve us well as we took endurance and firepower to another level—revolutionizing undersea warfare in an amazing transformation that took only 12 years from the first fission on the squash courts in Chicago to USS *Nautilus* getting underway on nuclear power. Through the decisive professionalism and perseverance of the SSBN crews, coupled with an SSN team that constantly threatened the Soviet submarines and the rest of their navy, the United States smothered the Soviet Union, defeating them while avoiding a nuclear world war—the ultimate testimony to the value of deterrence and a validation of George Washington's statement that, "To be prepared for war is one of the most effectual means of preserving the peace."

We're now entering a fourth generation of undersea warfare, defined by even more aggressive area and access denial made possible by the proliferation of long-range precision weapons. This generation will also be characterized by pervasive ISR, vastly increased use of unmanned systems, and cyber and other "soft attacks." The security environment will again require us submariners to dig deep to stay ahead of these trends and preserve our superiority in the undersea domain. We must continue to define the destiny on and beneath the seas. We must continue to provide our leaders with the full range of responses—from fully clandestine to highly kinetic. We must continue to be ready to prevail in any maritime conflict should an enemy take us on.

As we look to our future, one thing is certain; our Force has never been more relevant or important to national security. As we've seen in history, our Force will continue to evolve with new platforms, new missions and, as you'll see in this edition, new payloads. Through these efforts, as outlined in the Design for Undersea Warfare, we will solidly support our CNO's tenets of "Warfighting First, Operate Forward and Be Ready."

I am incredibly proud of each and every member of the undersea team, including our families, who sacrifice along with us. Just as the earlier generations did before us, we fourth-generation undersea warriors will be ready to surge to any crisis—first to arrive and last to leave. Let it always be a comforting reassurance to our friends and the worst nightmare for our enemies to know that the U.S. Submarine Force is on the job.

Happy Birthday Submariners!



DIVISION DIRECTOR'S CORNER

"I'd like to ask for your ideas on how to best invest in the payloads of the future. If you have any ideas that you feel we ought to consider, please let me, or anyone here on the N97 staff, know about them."

Rear Adm. Barry Bruner, USN,
Director, Undersea Warfare Division

This issue of UNDERSEA WARFARE focuses on undersea payloads. As a young ensign reporting to my first submarine, USS *Pollack* (SSN 603), I was introduced to our then-state-of-the-art weapons—the MK 48 Heavyweight Torpedo and Tomahawk Land Attack Missile. Today's Submarine Force still fields evolved versions of these weapons, which, while capable against today's threats, may not be enough for the fight of the future.

One of the biggest challenges our Submarine Force faces today is determining which payloads will best take us into the future. There are lots of bounding factors involved, including the cost to develop any given payload and the likelihood of making it to production—all balanced against being able to effectively operate in the threat environment of the future. It's a daunting task when you step back and consider the challenges.

Adding to this challenge, we must press forward payloads in today's tight fiscal environment. We cannot afford to chase exotic solutions that do not fit into a broader picture of how the Navy can most effectively use its submarines. We will continue working to balance our books while at the same time providing the Navy a Submarine Force ready to fight and win both today and tomorrow.

That said, there is no better group than the people we're currently working with to take us in the right direction. Admiral Richardson and Admiral Wears have put together a logical process that ensures open and transparent communications, sharing of ideas, partnering with industry and the technical labs, etc.—all focused on formally generating priorities that we can work on collectively. Along that line, one of our most important payload issues is restarting production of the MK 48 ADCAP Torpedo. We are scrubbing every dollar to find a way to fund that effort—and we will continue to do so until we succeed.

We'll continue to work the details of how we align and prioritize the budget, but efficiently spending the taxpayers' money is an all-hands responsibility, so I'd like to ask for your ideas on how to best invest in the payloads of the future. If you have any ideas that you feel we ought to consider, please let me, or anyone here on the N97 staff, know about them. Although we no longer preach D.W. Demming's mantra of the best ideas coming from the ones who are actually "doing," we haven't forgotten that the undersea warfare community—you guys (and I mean that in a gender-neutral way)—are among the smartest, hardest working and most innovative people in the world. So I look forward to hearing your ideas.

In this issue you will read about torpedo lessons learned the hard way—sometimes at the risk of our Sailors. You will also read about how we took those lessons to heart and what our torpedo test program does today to prevent repeating those mistakes. We then address some future payload concepts and a vision of how submarines will deliver the right payloads, in the right quantities, to keep our nation safe. We're looking at everything from large-displacement unmanned undersea vehicles to the ability to launch a Prompt Global Strike weapon from a large-diameter payload tube in an SSGN or an enhanced *Virginia*. We're working to enter the next stage of warfare with vigor: Information and electronic warfare are becoming ever more important, and both will need payloads (perhaps autonomous underwater vehicles) to get them in position.

Finally, as undersea payloads and capabilities continue to evolve, we must also evolve the fleet-wide CONOPs that embrace the Undersea Warfare Commander, giving him the authority and direction to take the battle to the enemy and win. And the list goes on.

I recently had the chance to speak with retired Admiral Frank Drennan about some of our payload initiatives. In the picture above, we are standing in front of an SSGN mock-up showing the Universal Launch and Recovery Module concept for launching, recovering and stowing large unmanned underwater vehicles. The left tube shows how two commercially available vehicles could fit vertically inside one SSGN tube. The right tube shows the ULRM extended to provide a "runway" for UUV takeoff and landing. This mock-up has become a real conversation piece in the Pentagon and has helped people better visualize the possibilities.

We are in the middle of an exciting time of change—and there is a lot going on. *Superb!*

I hope you find the articles in this issue interesting—and I look forward to hearing your ideas about payloads.

Very Respectfully,

UNDERSEAWARFARE

The Official Magazine of the U.S. Submarine Force

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UNDERSEA WARFARE is the professional magazine of the undersea warfare community. Its purpose is to educate its readers on undersea warfare missions and programs, with a particular focus on U.S. submarines. This journal will also draw upon the Submarine Force's rich historical legacy to instill a sense of pride and professionalism among community members and to enhance reader awareness of the increasing relevance of undersea warfare for our nation's defense.

The opinions and assertions herein are the personal views of the authors and do not necessarily reflect the official views of the U.S. Government, the Department of Defense, or the Department of the Navy.

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Silver Inkwell Award Winner

LETTERS TO THE EDITOR

In keeping with **UNDERSEA WARFARE** Magazine's charter as the Official Magazine of the U.S. Submarine Force, we welcome letters to the editor, questions relating to articles that have appeared in previous issues, and insights and "lessons learned" from the fleet. **UNDERSEA WARFARE** Magazine reserves the right to edit submissions for length, clarity, and accuracy. All submissions become the property of **UNDERSEA WARFARE** Magazine and may be published in all media. Please include pertinent contact information with submissions.

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TO THE EDITOR

Everyone appreciates fan mail, and **UNDERSEA WARFARE** is no exception. Marilyn D'Alessio, the mother of a competitor in the International Submarine Races (ISR) at Carderock, sent us the following plaudits after reading Olivia Logan's piece on the ISR in the fall issue:

"What a wonderful surprise ... to see all the memories from the ISR 2011!"

"... reading your article made me feel that I was right back there watching all those kids who worked so hard trying to get to the finish line. I know *Umptysquatch V* never made it to the finish, but knowing our kids made it worthwhile just to see them compete and have the opportunity of a lifetime. ... I was so thrilled just being there, getting an education from the sidelines in submarine competition and sitting at a facility that was so impressive—and the people so genuine; I never felt like just a 'visitor.'"

"Mikey [D'Alessio's son] was so thrilled to see the magazine he took it back to college with him this weekend.... [His friends] were all impressed with the magazine, and so was I. It's so beautiful, and I love the gloss to the paper, which makes the pictures pop and the articles easier to read."

We thank Mrs. D'Alessio for her kind words.

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SAILORS FIRST



Sailors of USS *Dallas* (SSN 700) returning to Groton, Conn., Dec. 14 at the end of a six-month deployment rush to meet their families on the pier.

Photo by Petty Officer 1st Class Virginia K. Schaefer

Since the demise of the Soviet Union, the U.S. military has been in transition, responding to an altered geostrategic landscape and the proliferation of advanced military systems. At the low end of the spectrum, U.S. forces face the challenges of humanitarian assistance and irregular warfare. At the high end, China is emerging as a new peer competitor with a different philosophy than its Soviet predecessor. Instead of building a large sea-going fleet, China is seeking to counter U.S. aircraft carriers and other sea-based power projection forces with an anti-access/area denial (A2AD) strategy based primarily on aerospace power, especially anti-ship cruise and ballistic missiles.

It's all about payload

Submarines are well equipped to confront the full spectrum of emerging challenges—including A2AD systems, to which they are

tubes originally designed to hold large strategic ballistic missiles, each SSGN added tremendous payload volume. In addition, the large-diameter muzzle hatches of their missile tubes provided a much more flexible ocean interface than the traditional small hull openings for 21-inch torpedoes and Tomahawk missiles.

In 2011, USS *Florida* (SSGN 728) dramatically confirmed the value of the SSGN concept by shooting 93 of the 122 Tomahawk cruise missiles launched from submarines against targets in Libya during Operation Odyssey Dawn. Most SSGN payload tubes currently hold canisters containing seven Tomahawk land-attack missiles, but the tubes' size and operational flexibility also give them the potential to accommodate many other payloads, including recoverable undersea vehicles. However, the Navy will lose the SSGNs' tremendous payload vol-

The Integrated Undersea Future Strategy (IUFS) introduced by Submarine Force leadership in the spring of 2011 includes a goal to add the VPM concept to *Virginia*-class submarines beginning with Block V. With the first Block V boat scheduled to start construction in 2019, VPMs would begin joining the fleet just as the SSGNs are leaving it. Of course, it would take some time to build up this new strike force, and it is unlikely the Navy could—or should—replace all 88 payload tubes currently provided by SSGNs. Whereas the SSGNs' striking power is concentrated in only four ships, the VPM concept would spread it across many more platforms, which has significant operational advantages.

The current Block III *Virginias* already have two tubes in the bow with the same diameter as an SSGN's, but the bow location limits their length. Located amidships, the VPM's large-diameter tubes could be

THE VIRGINIA PAYLOAD MODULE

A Revolutionary Concept for Attack Submarines

largely immune—but only if they can carry the required payloads. Warships never have enough offensive payload capacity, as any planner can attest. This is especially true in the Pacific, where the distance to reload ports is most challenging. Surface forces find it particularly difficult to carry enough offensive firepower when they are within range of A2AD systems, which force them to devote a large part of their payload to defending themselves. In contrast, submarines, which rely on stealth for their defense, can dedicate their entire payload to offensive operations.

A Nuclear Posture Review (NPR) recommendation approved in 1994 provided an unprecedented opportunity to radically increase the Submarine Force's aggregate payload capacity at very reasonable cost. The NPR recommended reducing the number of strategic ballistic missile submarines (SSBNs) by four boats, which the Navy promptly converted to guided-missile submarines (SSGNs) for conventional strike and special operations. With 24 vertical

tubes and flexibility as these ships begin to retire in 2026, and that has driven a search for other means of launching high-volume conventional strikes from beneath the sea as well as supporting alternative payloads.

The *Virginia* Payload Module (VPM) concept

The 2009 Quadrennial Defense Review specifically directed the Navy to study methods to increase submarines' conventional strike capacity. The resulting study identified several options, including converting more SSBNs into SSGNs if a future Nuclear Posture Review made additional SSBNs available, building new SSGNs from scratch, and inserting a new payload module during the construction of future *Virginia*-class attack submarines (SSNs). Further analysis concluded that the concept of a *Virginia* Payload Module represented a viable alternative to additional SSGN conversions (which would be nearing the end of their service life) or an unaffordable new SSGN class.

somewhat taller—albeit not as tall as SSGN tubes due to the smaller diameter of the *Virginia* hull. Their greatest advantage, however, would be accessibility. Whereas the bow tubes are outside the pressure hull and therefore inaccessible while the submarine is at sea, the VPM concept would provide access from inside the pressure hull. Block V *Virginias* would be the first SSNs with this capability, which is essential for carrying any payload that requires inspection, servicing or manipulation while underway.

In addition to its payload tubes, a VPM could provide reconfigurable internal volume for payload support, mission planning, and/or additional berthing. Although a payload module would of course lengthen the ship and increase its displacement, those changes would not preclude performing any SSN missions.

Developing the VPM concept

Adding modules—or “hull plugs,” as shipbuilders call them—to attack submarines is nothing new. The Navy installed hull plugs



Graphic courtesy of General Dynamics Electric Boat

during construction of the last ten boats of the *Sturgeon* (SSN 637) class in order to experiment with new propulsion systems and increase mission capabilities. More recently, General Dynamics Electric Boat installed a 100-foot module called the Multi-Mission Platform during construction of USS *Jimmy Carter* (SSN 23) in 2005. These modifications demonstrated that stretching submarine hulls is feasible, and stretching the *Virginia* class would involve less risk because it is the first submarine class specifically designed to accept hull modules during construction.

In developing the VPM concept, Electric Boat engineers adhered to the following tenets:

- Minimize the impact on the operating characteristics of the baseline ship.
- Minimize changes to the baseline ship's internal and external systems.
- Minimize the cost and risk associated with adding a VPM to future hulls.
- Avoid designing a point solution so a VPM could adapt readily to the widest range of future national security challenges.

- Provide a large ocean interface so that a VPM could share payloads with the SSGNs.
- Ensure that payloads can interface with the ship in a manner similar to the SSGNs.

With these tenets in mind, the engineers broke the concept down into three parts. The first was the basic hull module—the “truck” that would provide additional capacity to house today’s payloads and the flexibility to accommodate different payloads in the future. The second was payload “middle-ware,” a generic term for common electronic and physical interfaces with the ship that are designed to support the widest possible variety of payloads. The third part was the payloads themselves, including potential alternative payloads.

Configuring the VPM

Early versions of the VPM concept included up to eight large payload tubes, with the

tubes lined up two abreast. However, placing the tubes outboard separated by a centerline passage made their muzzle doors protrude beyond the ship’s molded lines. That necessitated a turtleback structure, with attendant hydrodynamic and potential acoustic problems, especially at the higher speeds SSNs are capable of. Since the payload tubes and their muzzle hatches are heavy, a large number of tubes also meant the hull plug had to be longer in order to float the ship.

The current concept, with four payload tubes located on the ship’s centerline, strikes a good balance of ship length, impact on auxiliary systems (e.g., air conditioning, ventilation, trim and drain systems) and operational capability. It allows the tubes to be as tall as possible without protruding beyond the molded line of the ship, thereby maximizing not only their internal volume, but also the length of the weapons and other payloads they might hold. Along with the two vertical tubes in the bow (which hold six missiles each), four VPM tubes would increase the ship’s maximum Tomahawk load-out to 40 missiles.

The pressure hull in the VPM concept tapers in from 34 feet fore and aft to a 26-foot wasp waist around the missile tubes. The wasp waist provides space outside the pressure hull for the bulky, large-diameter hatch mechanisms. An outer, non-pressure hull maintains the ship’s 34-foot beam and encloses the hatch mechanisms and the bottom of the tubes within the molded line of the ship. The volume between the inner and outer hulls also houses additional ballast tanks and could potentially accommodate future external payloads as well.

Fitting the VPM into the ship

The best place to insert a VPM into the ship appears to be between the normal fuel oil (NFO) bulkhead (the forward-most bulkhead of the propulsion spaces) and the operations compartment. This location would minimize disruption of the successful *Virginia*-class construction program. It would also avoid any alteration of the baseline *Virginia*-class operations compartment, with attendant operational benefits ranging from training to logistics.

The VPM area forward of the payload tubes would house auxiliary equipment needed to support the added space and payload tube operations. The second of three decks in that area could also provide reconfigurable mission space to accommo-

Never before has a hull plug promised payload space that could so easily be reconfigured to support new missions and new technology over a 30-year ship life. The VPM concept promises not only to enhance the Submarine Force's ability to leverage emerging technology and keep pace with evolving threats, but to dramatically expand the missions U.S. attack submarines can undertake.

date temporary berthing for special operations personnel or to serve as a mission planning area for unmanned vehicles or other payloads. While this is only a fraction of the space an SSGN can provide for such purposes, it represents an entirely new capability for an SSN. A smaller area aft of the tubes would contain high-pressure air flasks and an enlarged storekeeper's office with dedicated stowage lockers, which are always in short supply. Access between the propulsion spaces aft and the operations compartment forward would be through the VPM's upper deck.

Middleware to link ship and payload

Supporting new payloads beyond today's Tomahawk missiles will call for new interfaces between the payload and the ship. In the VPM concept, these interfaces are known generically as "middleware," a term borrowed from the world of computer software. In a computer, middleware provides a common interface between the operating system and the many different applications the computer hosts. In the VPM concept, it would provide a common interface between the submarine and the many different payloads a VPM might carry.

Unlike computer middleware, payload middleware for a submarine must include

not just data interfaces, but also connections for power and cooling, and even structures and mechanisms to support and move the payloads themselves. Like computer middleware, VPM middleware would need to use standards that are as modular as possible so it could support the widest possible range of payloads. For example, the flexible topol-

ogy of the *Virginia*-class electronic network would enable payloads to access whatever ship data they require.

Innovations such as inductive power transfer and laser data transfer are being considered and would go a long way toward the goal of using modular standards to support diverse payloads. Inductive power transfer does not require electrical connections. Instead, it transfers electric power between the ship and payloads via magnetic fields, minimizing connector maintenance in a saltwater environment. Similarly, lasers could transfer data between the ship and payloads via small transparent windows in the payload skin. This would also avoid the need for electrical or fiber-optic cables and their maintenance.

Another example of payload middleware is a common submarine launch system. U.S. attack submarines currently carry only torpedoes, which are launched hydraulically, and encapsulated Tomahawk cruise missiles, which are ejected from the capsule with gas pressure. However, potential future payloads could range from a more advanced and higher-speed strike weapon to unmanned surveillance systems and decoys. The Navy cannot afford to acquire and support a different launch mechanism for each individual payload.

Several candidates for a common launch system are under development, among them, capsules that float to the surface, water-

(Previous page) Illustration of the *Virginia* Payload Module concept. The VPM concept would give attack boats similar to USS *North Carolina* (SSN 777), shown below, some of the payload flexibility currently embodied in SSGNs like USS *Georgia* (SSGN 729), opposite.



Photo by Petty Officer 1st Class David Mercil

piercing systems that allow payloads to rise to the surface in a gas jet, and a universal launch and recovery module that mechanically lifts payloads out of the tube. These systems require further test and evaluation, but they must also be ready soon enough to support experimentation with the new payloads that are now in the works.

An efficient strategy for innovation

The VPM concept would be an efficient way to adapt the SSN fleet for the future. It would serve as the basis for a spiral-development process that could constantly improve attack submarine capability to keep pace with changing threats and technology. By greatly increasing the payload capability of future *Virginia*-class boats, it would avoid all the non-recurring costs that would be involved in developing a new submarine class for that purpose. And because the design of a VPM could evolve to support new payloads with only modest, affordable changes to the baseline ship, the Submarine Force would reap the many life-cycle savings inherent in a single, large class of attack boats, some of which will remain in service well past 2060.

At the same time, evolution of the module itself would provide design work to help sustain important elements of the submarine design industrial base. Several variants of the basic VPM concept are already being evaluated. One would provide

a bottom ocean interface (BOI). Another would support a special operations force (SOF) complex.

BOI hatches on the bottom of the VPM tubes would facilitate the launch and possibly the recovery of payloads like seabed sensor systems and offensive mines. Negative buoyancy would provide the launch force, simplifying arrangements in the tube. A SOF complex would have a large, side-opening door to facilitate the launch and recovery of swimmer delivery vehicles and other small manned submersibles. A side-door configuration would also be suitable for launching and recovering the large unmanned undersea vehicles that are likely to play an increasing role in undersea operations, especially in areas where the risk is too great for the submarine itself to operate.

Revolutionary potential

Beyond the initial evolutionary benefit of more than tripling the maximum *Virginia* Tomahawk load-out, the VPM concept offers many advantages that could be revolutionary in nature. Although a fleet of VPM SSNs would not quite match the tremendous payload capacity of today's SSNs, they would spread that capacity across an unprecedented number of submarines. The VPM concept also has the flexibility to accommodate an unprecedented variety of payloads. To name just a few, it could carry unmanned aerial and undersea vehicles for intelligence, surveil-

lance and reconnaissance; swimmer delivery vehicles for special operations; seabed sensor arrays; and even miniature air-launched decoys (MALD) designed to jam or spoof enemy radars.

Never before has a hull plug promised payload space that could so easily be reconfigured to support new missions and new technology over a 30-year ship life. The VPM concept promises not only to enhance the Submarine Force's ability to leverage emerging technology and keep pace with evolving threats, but to dramatically expand the missions U.S. attack submarines can undertake. Building on the already formidable mission capabilities of U.S. submarines, this would give combatant commanders many new options for confronting the growing challenges to American military power.

Retired Navy Capt. Karl M. Hasslinger is a former attack submarine commander who currently serves as Electric Boat's Director of Washington Operations. John Pavlos is an Electric Boat engineering manager who leads the *Virginia* Payload Module development program



Photo by Petty Officer 1st Class John Parker

At the outset of World War II in the Pacific, America's advanced heavyweight torpedo, the Mark 14, failed to perform as designed, crippling American submariners' ability to take the war to the enemy. The American submarine community has never forgotten that failure, or the inadequate testing that led to it. Out of that painful experience came the rigorous, realistic testing that ensured the effectiveness of American torpedoes throughout the second half of the 20th century. In the 21st century, heavyweight torpedoes remain our submarines' primary offensive and defensive weapons, and robust testing remains essential to make sure that our submariners can always rely on them.

KEEPING IT REAL

Rigorous, Realistic Testing Ensures Effective and Reliable Torpedoes

Today's torpedo is of course much more capable and much more complex than the MK 14 as it has to be to meet today's challenges. The target set has grown dramatically just in the last 20 years. In addition to the blue water threat, a torpedo must now be effective against diesel-electric submarines operating quietly in shallow coastal waters. In addition to traditional ocean-going surface combatants, it must now deal with small and mid-size high-speed vessels, not to mention surface action groups that include a mix of ships. At the same time, most of these threats have become more adept at counter-detection, counter-fire, and evasion. The Submarine Force must be able to kill this wide range of difficult, capable, constantly evolving targets with a single weapon in what is perhaps the most challenging environment for any weapon system.

State-of-the-Art Testing

Extensive torpedo testing on multiple levels across the undersea enterprise is more essential than ever for maintaining readiness, assessing performance, developing and refining tactics, and countering emerging threats.

The Submarine Force typically conducts over 500 exercise firings per year. These firings support not only fleet readiness and training and tactical development (TACDEV), but also developmental testing and operational testing (DT/OT) of system improvements and new capabilities.

It has become standard practice for most firings to serve multiple objectives. There are simply not enough resources—submarine availability, range availability, target ships, countermeasures, exercise torpedoes, etc.—for each training and testing activity to “do its own thing.” A host of activities—including program offices, fleet schedulers, fleet trainers, Submarine Development Squadron Twelve, the Naval Undersea Warfare Center (NUWC), and the Navy's Operational Test and Evaluation Force—continuously plan and coordinate to make limited firings meet everyone's objectives as well as possible.

It helps that torpedoes are unique among weapon systems in having an exercise variant that can be recovered and reused after firing—unlike missiles or gun projectiles, which cannot be recovered and reused.

In an exercise torpedo (EXTORP), the warhead section is replaced by an exercise section containing data recorders, range tracking instrumentation, and redundant safety mechanisms to prevent inadvertent impacts with own-ship or target vessels. However, other than a reduced fuel load and the lack of an explosion at the end of its run, an EXTORP performs exactly the same as a full-up warshot in every respect.

Every EXTORP firing provides a wealth of data that supports multiple objectives, from training to ensuring performance and reliability to developing tactics and systems. And after several firings, every EXTORP is converted into a warshot, a full-up round for use in combat. The fact that every warshot in U.S. submarines has already run as an EXTORP significantly improves reliability.

Live Testing for Fleet Training

Submarine crews require realistic training to certify and maintain proficiency. Since a submarine-launched torpedo is not a “fire and forget” weapon, operator training must ensure equal proficiency both before and



Ex-USS *John Young* (DD 973) after being struck by a single Mk 48 Mod 6 warshot torpedo, fired by USS *Pasadena* (SSN 752), April 13, 2004.

after launch. And it must ensure proficiency with a wide variety of complex systems, including as many as 14 major variants of combat systems and multiple variants of torpedo hardware and software. It must take into account variations in input and performance capability across all of these systems, variations that can range from very great to very subtle and can affect both pre-launch and post-launch training.

Prior to launch, a crew must execute approach and attack tactics, develop a satisfactory firing solution, and prepare the weapons—all while maintaining a tactical advantage and determining what tactics to employ after launch. In performing target motion analysis (TMA) and developing a satisfactory firing solution, they must consider numerous characteristics of the combat system, the operating environment, and the target. Once weapons are launched, they must respond quickly and correctly to the rapidly evolving tactical situation—including evasion and counter-fire by the target—both to maximize the probability of a hit (P_{hit}) and to ensure the submarine's own survivability.

Only actual weapon firings can ensure crew proficiency in all of these complex and demanding tasks. Land-based simulators and onboard trainers have improved to the point where they can increasingly augment live training, but they cannot replace it without sacrificing the critical ability to “train as you fight.” Serious shortcomings in emulating torpedoes, operating environments, and targets make them inadequate substitutes for actual torpedo firings.

Among the many fleet training evolutions that call for exercise firings are tactical readiness exams (TREs), periodic proficiency tests, and Submarine Command Course (SCC) exercises. The SCC exercises involve the most extensive and most visible torpedo training tests. A typical quarterly SCC exercise includes three submarines, multiple surface combatants and aircraft, and up to 70 torpedo firings in a mix of anti-submarine and anti-surface warfare scenarios in both deep and shallow water.

In addition to their training value, exercise firings provide critical insight into torpedo performance. This is particularly true of SCC exercises, which offer some of the most

challenging tactical scenarios. Multi-target scenarios in deep and shallow water; aggressive counter-tactics, including deception, evasion, countermeasures and counter-fired torpedoes; and even occasional exploration of alternate tactics provide particularly robust tests of weapon system performance.

Platform Readiness and Certification

A submarine is one of the most complex platforms in the Navy. Dozens of shipboard systems, procedures, and human factors come into play in shipping, stowing, handling, tube-loading, launching and controlling a torpedo. Heavyweight torpedo firings are among the few end-to-end tests for making sure the entire undersea combat system—sonar, combat control, launcher, weapons, etc.—is operationally ready for deployment. While the more than 500 firings per year mentioned above may sound like more than enough to ensure readiness and proficiency, it amounts to only a handful per year when divided among more than 80 submarine crews—and fewer still for crew members who rotate during the year.

Tactical Development

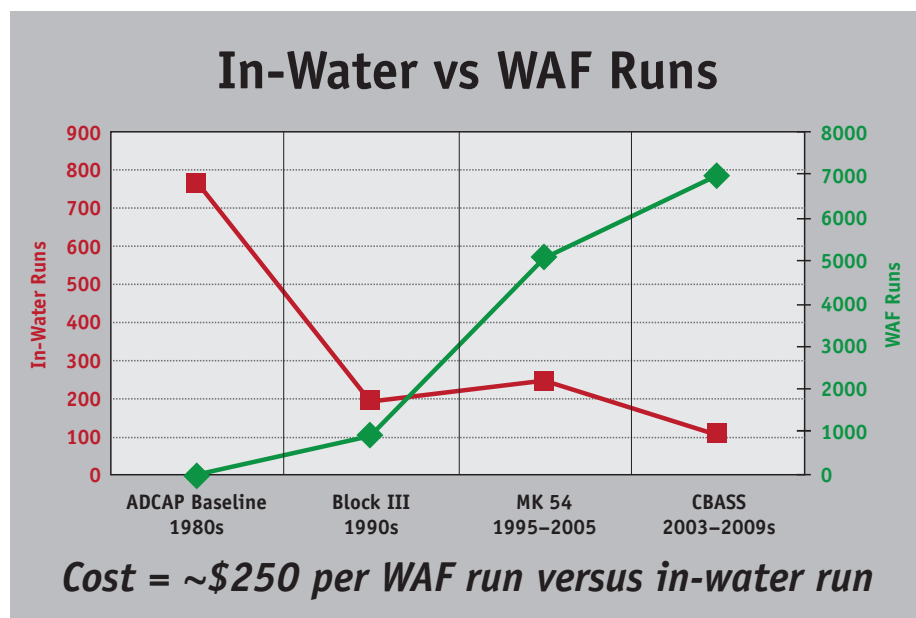
The Submarine Force must constantly develop its tactical guidance to keep pace with evolving and emerging threats as well as new sensor, combat system and torpedo capabilities. The only sure way to assess the effectiveness of approach, attack and employment tactics is to take all the systems to sea and test them against appropriate threat surrogates. Each year, some 50 heavyweight torpedoes are fired in TACDEV exercises carefully planned and executed with specific mission-based objectives in mind. Moreover, many fleet training firings and DT firings are also leveraged to address TACDEV objectives such as building a case for altering or replacing specific tactical guidance.

Development Testing/Operational Testing

The MK 48 heavyweight torpedo has continually evolved from the Mod 1 version introduced in the 1970s to the Mod 6 and Mod 7 CBASS variants in service today. Hardware and software upgrades have improved performance, reliability, maintainability, and suitability, keeping the overall system state-of-the-art. Each major upgrade requires at-sea testing from initial data gathering and concept exploration through engineering development and formal development. Subsequent operational testing to determine if a system should be fielded must, by definition, take place at sea.

However, development programs today involve a lot fewer dedicated firings than in the past. Technical evaluation of the original MK 48 Mod 5 ADCAP in the mid-1980s included more than 700 dedicated in-water runs over two years, followed by about 250 runs for OT. The funding and testing resources available now simply cannot support numbers of that sort. To obtain as much performance data as possible, developers have therefore combined DT and OT with fleet training and TACDEV testing and have also worked with Australia, our torpedo development partner, to spread the burden. Meanwhile, an integrated test approach has blurred the once-sharp distinction between DT and OT, and greater use of modeling and simulation (M&S) has helped compensate for the reduction in at-sea testing.

The current Spiral 4 heavyweight torpedo software development program is an example of the drive to make each live firing meet



Trend in use of Weapons Analysis Facility (WAF) simulation vs. in-water testing for torpedo development programs since the 1980s.

multiple objectives. Now in the OT phase, which will continue through FY 12, Spiral 4 incorporates major changes to sonar, signal processing, and search logic. It was difficult to justify “piggybacking” Spiral 4 objectives on fleet training firings during early development, since the Spiral 4 version differed so greatly from torpedoes already in service and was not yet mature enough to have training and employment guidance available. However, now that Spiral 4 is in OT and nearing unrestricted fleet release, the fleet is exercising with Spiral 4 weapons, providing regression test data for OT assessment at the same time that it lays the groundwork for operational deployment.

Modeling and Simulation

M&S has played a growing role in torpedo testing as torpedo performance requirements have become more diverse and complex and at-sea test opportunities have diminished. A variety of M&S tools and capabilities are supporting torpedo development, testing and training. The Weapons Analysis Facility (WAF) at the Naval Undersea Warfare Center’s Newport Division hosts the Navy’s highest-fidelity torpedo simulation. This includes torpedo hardware in the loop (HWIL), with a full-up torpedo guidance and control section sitting in an electronics rack at the core of a matrix of high-performance computers that model weapon dynamics, sonar propagation, targets, and the undersea environment. The

production-representative hardware runs with the same operational software used in a fleet torpedo. When the “fire” signal is given, the torpedo runs in real time, executing whatever mission or test the developers and analysts have designed.

NUWC scientists and engineers collaborate with the Office of Naval Intelligence and other activities to develop high-fidelity submarine and ship target models that faithfully replicate acoustic and dynamic properties a torpedo sees in an actual target. Similar effort has gone into replicating the under-sea environment so that the guidance and control section responds as if it were on a torpedo in the water pursuing a live target. In effect, it’s as if the guidance and control were wearing a virtual-reality helmet. This allows NUWC Newport to make thousands of runs to support the development and testing of upgrades while preserving precious in-water tests for verifying and fine-tuning those improvements.

Since 2006, it has also been possible to connect the WAF to the Submarine Multi-Mission Team Trainer (SMMTT), allowing SMMTT students to “shoot” and observe a virtual torpedo of much greater fidelity and realism than the trainer’s own simplistic models can provide. Meanwhile, other M&S tools are addressing the deficiencies in those organic trainer models. Under a training community initiative to replace multiple land-based and onboard torpedo training



A technician at NUWC's Weapons Assessment Facility prepares hardware for integration testing. The increasing quality of hardware-in-the-loop simulations, together with their low cost and repeatability, enables them to play a growing role in torpedo testing. However, sufficient testing of real torpedoes in real-world environments is still required to ensure effectiveness and reliability.

models of varying pedigree with a higher-fidelity digital model, the Penn State Applied Research Lab developed the Technology Requirements Model (TRM) suite as a baseline digital model to support multiple training applications. TRM is already integrated into some SMMTT equipment.

Warshot Testing

There are numerous accounts from the first part of World War II in the Pacific of U.S. submarine skippers firing salvos with perfect solutions only to have the torpedoes run under the target or strike it without exploding. In at least one case, a torpedo circled back and detonated on the boat that launched it. All of these problems were eventually resolved, but thorough testing could have identified and resolved them before the war, giving American submariners weapons they could rely on from the outset. The testing and development communities have never forgotten that lesson.

Exercise torpedo firings obviously do not fully test the explosive train. A full end-to-end test requires an all-up warshot. The Submarine Force therefore checks the reliability and lethality of its torpedo inventory by expending up to four warshots per year in live-fire service weapon tests (SWTs) or ship-sinking exercises (SINKEXs). SWTs use a special-purpose expendable submerged target on which a torpedo can detonate as it would on a hostile submarine. SINKEXs

use a decommissioned surface vessel to demonstrate a torpedo's ability to hit and sink a warship on the surface. Posters on walls and bulkheads across the submarine community show the dramatic result of successful SINKEX firings.

End-to-end warshot testing is essential for maintaining confidence in the effectiveness of the warshot inventory. In April 2003, for example, two successive SINKEX torpedoes experienced reliability failures. Alerted and concerned, the submarine community convened a Warshot Reliability Action Panel (WRAP) with representatives from across the submarine community, the warfare centers, industry, and academia. With the Submarine Force Commander himself providing flag oversight, the panel investigated the root cause, got a clear picture of reliability in the torpedo inventory, and recommended a course of action to improve reliability.

The WRAP recommended a statistically significant Warshot Torpedo Evaluation Program (WTEP) of exercise firings, land-based testing, live-fire testing, and warshot inventory reliability enhancement (WIRE) firings to continuously monitor and demonstrate reliability. WIRE firings involve pulling warshot torpedoes from inventory and converting them to exercise units with minimal testing and rework. This yields greater insight into reliability, the maintenance cycle, and shelf-life characteristics

than a standard exercise torpedo, which typically takes 90 to 120 days from build-up to firing.

While torpedo effectiveness and reliability figures are classified, it is worth noting that there have been no failures in warshot tests since implementation of the WRAP recommendations.

Performance and Reliability Analysis

The test programs discussed above produce a huge volume of data that helps us understand and improve torpedo performance and reliability. NUWC's Newport Division maintains performance and reliability databases that capture data and analysis from virtually every heavyweight torpedo firing. The databases track over 1,500 performance and reliability parameters and support the production of periodic summary reports, trend analyses, and answers to performance and reliability queries from activities across the undersea enterprise.

Among the benefits of this systematic analysis and tracking are the ability to:

- Identify effectiveness and reliability issues
- Identify gaps in training
- Predict or estimate the performance of emerging threats
- Identify gaps in testing (i.e., where we need more data)
- Provide a performance baseline against which to gauge system upgrades
- Prioritize performance and reliability improvements
- Improve and refine employment tactics, techniques, and procedures.

An old poster of the very first MK 48 ADCAP warshot firing—when USS *Norfolk* (SSN 714) sank the *ex-Jonas Ingram* (DD 938) way back in July 1988—bears the quote: “Test the system in extremis in peacetime, so that system does not put you in extremis during wartime.” The source of that quote has been lost, but the torpedo testing community could not have a better motto. And for our submarine warfighters, they are words to live by—literally!

Mr. Freeman recently retired from a 37-year career in undersea weapon test and evaluation at the Naval Undersea Warfare Center. He most recently headed the Fleet Operational Readiness Division in the Torpedo Systems Department of NUWC's Newport Division.

Question and Answer

Rear Admiral Barry Bruner Director, Undersea Warfare Division (N97)

Rear Adm. Bruner is the director of the Undersea Warfare Division (N97) in the Office of the Chief of Naval Operations. As N97, he coordinates undersea warfare policy, planning and programming and is resource sponsor and principal Pentagon advocate for the Submarine Force.

Admiral Bruner received his commission from Officer Candidate School in 1981 after graduating from Arizona State University. He earned a master's in oceanography and meteorology from the Naval Post-Graduate School. He served in USS *Pollack* (SSN 603) for three Western Pacific deployments, in USS *Mariano G. Vallejo* (SSBN 658) (Gold) for five strategic deterrent patrols, and in USS *Newport News* (SSN 750), including a deployment during the 1990s Balkan conflicts. From 1998 to 2001, he commanded the Gold crew of USS *Florida* (SSBN 728).

His shore tours have included command of Submarine Squadron Seven, chief of staff for Carrier Strike Group 5/Task Group 70 and 75, the Navy Staff, and most recently, command of Submarine Group Ten.

Admiral Bruner recently discussed the Navy's strategy for submarine tactical payloads with UNDERSEA WARFARE Magazine:

Q: When you heard you were coming to Washington to head OPNAV's Undersea Warfare Division, did you expect to be focusing so much on the future of payloads?

A: Frankly, it didn't surprise me. I was weapons officer on *Pollack*, the first ship I served in, and later ops officer in *Mariano Vallejo's* Gold crew, so I saw firsthand that bringing weapons to bear on an enemy is the ultimate measure of any warship. Since then our understanding of payloads has gotten more complex. They're not just weapons anymore. While the Navy continues to value the traditional submarine combat prowess, there's been a growing recognition of the submarine's intelligence-gathering capabilities and the role it can play in shaping the landscape prior to war. The Submarine Force stands ready to fight and win our nation's wars, but if we can provide national decision-makers with the information or options necessary to prevent war, all the better.

While submarines still often operate "alone and unafraid," we're moving into a future where we need to expand each submarine's range of influence. We'll need to share data with off-hull sensors and platforms to build the "big picture" prior to combat and then provide effective command and control for longer-range weapons.

Q: So what's your first priority?

A: My first priority is an integrated plan for the future. Because of the time involved in building each submarine and their 30- to 40-plus-year lifespan, we're now feeling the effects of decisions made decades ago. The timing of these effects, along with fiscal constraints, means that we need to attack multiple problems at one time. So the Submarine Force has developed an Integrated Undersea Future Strategy designed to shape the future of platforms, payloads, payload volume, people, and force posture. It's a comprehensive strategy to make us successful in tomorrow's operations and—if necessary—tomorrow's warfighting.

Q: What does that mean for payloads?

A: We could develop the fastest, most lethal, most accurate missile in the world, but if we can't deploy it in sufficient quantity to have the desired effect, it would be a poor investment indeed. So there must be a balance between the payload, its integration with shipboard systems, and its cost.

Our nearest need is for more heavyweight torpedoes. For years we've bought upgrade kits, constantly modernizing our torpedo inventory, but from the fleets, the request is clear: "We need more torpedoes!"

Beyond that, we're beginning to expand beyond the "tyranny of the 21-inch tube." Until recently, with the conversion of the four oldest *Obios* into SSGNs, our payloads were limited to the dimensions of our 21-inch torpedo tubes and vertical launch cells. While ADCAP and TLAM prove we can do a lot in a 21-inch form factor, the laws of physics do limit what we can do. The *Seawolf* class has 28-inch torpedo tubes, but with only three submarines in the class, this does not provide an effective path for larger



Photo by Olivia Logan

Rear Adm. Bruner briefs the Naval Submarine League on submarine payload initiatives.

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payloads. The large diameter of the SSGN payload tubes finally opened the aperture on what submarines can host.

Building on this payload flexibility, we made the decision to replace the twelve 21-inch vertical launch cells with two SSGN-like large-diameter *Virginia* Payload Tubes. The first SSN with these tubes will deliver in 2014 and will provide an enduring platform for large-diameter payloads beyond the SSGN retirement in the late 2020s.

Beyond the SSGNs, we’re looking at the potential for additional large-diameter tubes through a concept called the *Virginia* Payload Module. While there’s still much work to be done on the design, the concept would add four additional tubes to future *Virginia* SSNs, making them capable of carrying 40 Tomahawk missiles. These additional tubes would also provide additional flexibility over the forward tubes, since they’re inside the pressure hull and would allow manned access while underway.

Q: We’ve heard that the Block V *Virginia*, with VPM, will start construction in

2019. With the SSGNs scheduled to begin retiring in 2026, won’t that leave a gap in payload capacity until a sufficient number of VPM *Virginias* can be built to fill it?

A: We’re just beginning the true pencil-to-paper engineering for VPM. While we have Navy and DoD funding support to bring the design to maturity in time for Block V, the decision to begin VPM production will be made through a standard DoD procurement process.

We’ve looked at the options, and we believe VPM is clearly the way ahead. With the SSGN retirement occurring at the same time as the pending SSN shortfall, and then the need to build the next-generation SSBN, building new SSGNs is simply not in the cards. If approached with the rigor that is the hallmark of submariners, designing and delivering VPM can be done so as to maintain the necessary undersea payload volume.

Q: You’ve mentioned the flexibility of the VPM’s accessible, large-diameter tubes.

What sort of payloads do you have in mind for the VPM?

A: I’m not limiting myself to payloads for a specific platform or launching system. The beauty of large-diameter tubes—whether we’re talking SSGN, *Virginia* Payload Tube, or VPM—is that sheer volume and large ocean interface create additional possibilities. To store the energy needed for an AUV to conduct multi-day, independent operation requires that additional space. That kind of space is only available today on an SSGN or maybe a Dry Deck Shelter-equipped SSN. Conversely, for smaller payloads, we can create multi-payload canisters like those used for TLAM.

Q: Are you thinking primarily about land attack for VPM?

A: TLAM capacity is the primary driver right now for VPM, but we’re also looking at other options for land attack as well as other missions.

At some point the Navy will have to move beyond TLAM. It's a highly capable weapon, but it does have some limitations. A subsonic missile only travels so fast, and this presents long-term challenges in defeating advanced air defense networks or engaging high-value mobile targets.

Another potential weapon would be a next generation anti-ship missile. Extending the reach of anti-ship weapons is a goal across the Navy. For submarines, this could take the form of an anti-ship missile or an extended-range torpedo.

Q: Are any defensive weapons being considered for the VPM?

A: A submarine's first line of defense is its stealth. If you can't be found, you don't need to give up limited space for defensive-only systems. Compare that to a surface combatant, where a large number of the vertical launch cells are dedicated to anti-air missiles, limiting the number of cells available for offensive payloads like TLAM. Since payload space is limited, and the fleet demand for offensive power is high, adding new weapons to the submarine mix likely will not happen if it comes at the expense of our current offensive capabilities.

Beyond that, while not done with VPM in mind, we've previously demonstrated the ability to launch an AIM-9 anti-air missile from underwater. Consider the mindset change for a helicopter pilot if they knew that the first indication of a nearby submarine was an inbound missile. Again, we have to balance that against the striking power the Navy needs from its submarines.

Q: What about payloads that are not "kinetic"?

A: Non-kinetic payloads are a major future growth area where the flexibility and accessibility of the large-diameter tubes can pay big dividends. As mobile sensors advance, we can relieve our submarines from some high-risk or lower-payoff tasking. This will allow us to more efficiently use our submarines for the missions they're best suited for. Conversely, a submarine acting as the "mother ship" for a group of UUVs would give that submarine greatly extended eyes and ears. To bring this to fruition will require enhanced tactical communications and power systems.

For submarine, surface-ship, and independent use, the Navy is developing a

system called the Large-Displacement Unmanned Underwater Vehicle. The goal is for LDUUV to serve as a common "bus" that can carry various payload capabilities and operate independently for weeks on end. The Office of Naval Research is working on the navigation and autonomy needed for independent operations. ONR is already developing the energy storage needed to sustain onboard systems and propel the vehicle for weeks on end. Unmanned aircraft, ground vehicles and surface vessels can all take advantage of the efficiency humans have wrung out of air-breathing engines. Operating underwater, air-breathing engines don't work so well. This limitation is why the U.S. Submarine Force runs on nuclear power!

Q: Isn't that endurance goal ambitious?

A: Yes, but the endurance issue is one more reason why submarine support for LDUUV is important. Operating underwater creates incredible engineering challenges—challenges we have worked through for over a century in submarines. But the payoff from undersea systems is the stealth. Satellites, radars, and a Sailor's eye all have the same general limitation when it comes to seeing underwater. So how do you maintain the LDUUV's ability to covertly patrol an area if it doesn't have the legs for a long transit? You launch and recover by submarine.

Now launch and recovery from a submarine creates additional challenges, but we're investing in the technology to make it happen. We're building a prototype Universal Launch and Recovery Module that will extend from an SSGN tube and provide a horizontal platform. Further work will be necessary to shrink the design for tactical use in the shorter *Virginia* tubes. The goal is to leave as much of the tube volume available for the payload as possible. This concept may also open up new possibilities for supporting special operating forces in the future. Maybe we host the SEAL Delivery Vehicle in a vertical tube and operate without a Dry Deck Shelter.

Q: How soon do you expect that to happen?

A: LDUUV is still in the prototyping stages, but operational units will be available by the end of the decade. We don't want to wait until LDUUV is ready to smooth out all the expected kinks in manning, CONOPs,

launch and recovery, or command and control. We're going to move forward on the submarine interfaces and mission development now. The commercial industry already has UUVs available. These systems generally don't have the desired level of endurance or autonomy but will allow us to build on the database of knowledge. By approaching the payload and payload interface in a modular fashion, we follow the pace of innovation at a much lower overall cost.

Q: You said before that your near-term priority is restarting torpedo construction. Why is this necessary?

A: As you look around the world, the potential adversary navies are growing in size and sophistication. This presents the fleet with more potential targets, and targets that are best not attacked "head on." Submarines provide an asymmetric way of attacking surface ships and are still the most potent anti-submarine weapon in the arsenal. The message from the fleets is loud and clear: "We need more torpedoes!"

We've had tremendous success over the years upgrading the ADCAP performance. Current torpedo design, though, does impose some limitations. As we move forward, we're going to expand on some of the concepts in the UUV realm, primarily modularity. Modularity is already baked into how we build *Virginia* submarines and update our combat and sonar systems.

A more modular design for the torpedo would create a "bus" that would allow much more rapid upgrade to propulsion, energy storage, guidance and control, and/or payload. Yes, I know I'm now talking about interchangeable payloads on a payload. This will allow us to leverage new technologies as they become available. For example, we could enhance the weapon's navigation abilities now, and learn the lessons now, while waiting for long-endurance technologies to bear fruit. Or maybe the endurance comes first—a modular design allows us more decision space.

Q: What about defenses against torpedoes?

A: Adversary torpedoes are getting more effective, and we're taking that into account. Again, for a submarine, our primary defense is our stealth. Beyond that, we need to make sure our active countermeasures continue to pace torpedo development.



Photo by Senior Chief Petty Officer Gary Ward

(Above and on page 12) Rear Adm. Bruner views equipment components during a tour of the Honeywell facility in Tempe, Ariz.

Getting back to submarine stealth, the future may contain decoys that can spoof a variety of sensors. We normally think of stealth as lowering our signature, and this could be acoustic, hydrodynamic, electromagnetic, etc. But that is only half the equation. With sonar, we talk about signal-to-noise ratio. For some scenarios the payoff may be better if we raise ambient “noise.” For example, why not make a hostile helicopter spend time and fuel prosecuting a decoy periscope instead of prosecuting one of our submarines?

Q: At the Naval Submarine League Symposium this fall, you mentioned a new way to conduct prompt long-range strike against time-critical, high-priority targets. Could you tell us more about that?

A: The idea of promptly striking high-value targets anywhere in the world is not new. What *is* new are the advances in technology that would make it possible to do so. Today, the United States has the ability to promptly strike anywhere in the world, but only with nuclear weapons. The challenge, then, is: Can you build a system that is easily distinguished from our nuclear systems? We should try.

A maritime system is still at the concept stage, but it opens up many new options for national decision-makers. The long ranges possible would prevent an adversary from retaining a safe haven deep inland. The short flight times would allow engaging mobile targets that may not be possible today.

The far-forward nature of submarine operations also means that a submarine missile does not need nearly the same maximum range as a missile based in the continental United States. People typically underestimate the vast size of the Pacific Ocean. Moving the missile thousands of miles closer greatly reduces the technological jump required for success.

What I want to make clear is that this is not envisioned to be used on our SSBNs—that would lead to an unacceptable level of ambiguity to countries like Russia or China. In the past, people have floated the idea of replacing the nuclear weapons on a few Trident missiles with conventional bodies. While this is technically feasible, the potential for misinterpretation by other countries makes this untenable.

The next question is how many missiles would you need to field day-to-day for conventional deterrence, and how many

for surge at the start of the fight. Those are questions that still require study, and the answers will depend in large part on exactly what performance is possible.

Q: Before you have to get on to other business, is there any last thought you’d like to leave with our readers?

A: Over the last few years, senior leaders both in the Navy and the Department of Defense have used some submarine acquisition programs as examples of success—specifically, the *Virginia*-class program and the Acoustic Rapid COTS Insertion Program (ARCI). Much of the success is due to their modular concepts. We do not have the luxury going forward of pursuing exotic one-of-a-kind systems. Systems made of common, interchangeable parts are the way of the future. This allows for rapid, incremental changes that pace the advances of commercial technology.

Lt. Cmdr. John T. Gonser is the military editor of UNDERSEA WARFARE Magazine.



Everyone associated with undersea warfare appreciates the importance of submarine rescue, but most have little idea of what a rescue operation is like. Every rescue operation—indeed, every exercise—is unique, with a distinct mix of personnel, equipment, and procedures tailored to the specific situation. The following notional scenario is designed to give readers some understanding of what rescue assets are available, how a multinational rescue effort is organized, and how the U.S. Navy's submarine rescue organization can contribute to a successful outcome.

The call

Imagine you've recently taken command of Submarine Development Squadron Five (SUBDEVRON 5), in Bangor, Wash. You're responsible for the Navy's three *Seawolf* (SSN 21)-class submarines. You're also responsible for several other subordinate commands and detachments. One of these is the Deep Submergence Unit (DSU), in San Diego, Calif., whose mission is deep-ocean submarine rescue.

Now, in the middle of the night, your phone rings. You answer, and a recorded voice begins: "This is the Newport News Naval Shipyard submarine emergency alert system...." After asking you to confirm your identity, it reports that a submarine is disabled and asks you to confirm that you will support the response.

As an experienced undersea warrior, you know submarining is inherently dangerous. Even the extraordinary safety precautions taken by today's submarine forces can't guarantee that submariners will never need to be rescued from a sunken boat. That's why the DSU exists. You visited it briefly before taking command of SUBDEVRON 5. You spoke with its skipper, met the crew, and got a quick tour of the DSU compound on the tarmac of North Island Naval Air Station.

You found it hard to talk over the roar of aircraft taking off and landing, but you learned that this is the best location for quickly loading submarine rescue gear onto aircraft for transport to an emergency any-

where in the world. As a submariner, you didn't have to ask why speed is essential, or why the DSU's goal is to reduce the time to first rescue (TTFR) from a disabled sub anywhere in the world to three days (72 hours) or less.

Getting organized

If the disabled sub is American, you, as COMSUBDEVRON 5, will most likely serve as coordinator, rescue forces (CRF), the officer responsible for coordinating the entire effort. You log onto the website of the International Submarine Escape and Rescue Liaison Office (ISMERLO) to see what additional information is available and learn that the submarine isn't American.

When a submarine goes missing or sinks, the operational commander of that country's submarines—the SUBOPAUTH, in submarine parlance—automatically becomes the submarine search and rescue authority (SSRA) directing the overall response. The SSRA initiates an alert on the ISMERLO website, which sends out an instant short

message service (SMS) text message alerting submarine rescue professionals around the world. That was what triggered the call you received from Norfolk.

SUBDEVRON 5 has no wide-area search capability, so if the submarine has just gone missing in some general area, there's little you can do for now except stand by and explore alternatives. But in this case, the sunken submarine apparently came to rest on the bottom above crush depth, and the crew released an emergency buoy like the Submarine Emergency Position-Indicating Radio Beacons (SEPIRBs) carried in U.S. submarines. The buoy rose to the surface and broadcast a unique identification number registered to one of the submarine's escape compartments, alerting the SSRA and providing the sub's approximate position.

Since the submarine isn't American, you'll probably just oversee the U.S. contribution—unless the SSRA specifically asks that you also serve as CRF for the overall rescue effort. You soon learn through official U.S. Navy channels that the SSRA has indeed called Commander, Submarine Force, to ask that you be assigned as CRF, and the official written request is on the way from the submarine's country to the Pentagon via

the State Department.

The SSRA appoints an on-scene commander (OSC) to control all efforts at the site of the accident. As the senior officer at the scene, the OSC will need your support as soon as possible, so you notify your chain of command and hurry to board a plane at Seattle-Tacoma airport, accompanied by your squadron's master diver, medical officer, and reserve detachment CO.

Everyone is concerned about the 35 crewmembers on the disabled sub. As a submariner, you know that if a boat sinks without any immediate danger like fire, flooding, or rising pressure, uninjured crewmembers can survive five to seven days. On the other hand, the crew may be struggling with reduced oxygen, increased carbon dioxide, cold, heat, toxic gases, increased pressure, or some combination of these. If nothing else, they're bound to be traumatized.

If the depth is less than 600 feet, they could theoretically escape from the sub without assistance, but the sub may be deeper than that, and in any case, it's usually better to wait for rescue than to risk trying to escape with no help on hand at the surface. That's why it's important to minimize the time to first rescue (TTFR).

ISMERLO's role

Minimizing TTFR requires the sort of cooperative central planning that ISMERLO was designed to facilitate. Hosted by NATO's Allied Submarine Command and the U.S. Atlantic Submarine Force, in Norfolk, Va., ISMERLO has no command and control authority, but the databases and interactive tools on its website make it the world's primary source of information on submarine escape and rescue.

In a submarine emergency, the ISMERLO website becomes a virtual meeting place for the organizations involved—a clearing house for calls for assistance; informal offers of equipment, systems and medical personnel; and updates on the rescue effort. Experts around the world are now using the website's chat rooms and status boards to track the availability and status of rescue assets, follow events, and make recommendations. Everyone using it has access to a common picture of the evolving rescue effort.

Weighing rescue options

While you proceed to the rescue area, the casualty assistance team that has manned SUBDEVRON 5's rescue response center uses information gleaned from all available

(Opposite) The NATO Submarine Rescue System (NSRS)'s Intervention Remotely Operated Vehicle (IROV) above a bottomed submarine (Photo courtesy of NSRS). (Below) The U.S. Navy's Submarine Diving and Recompression System, including the Pressurized Rescue Module shown here, can be transported in a variety of large transport aircraft (Photo courtesy of DSU)





sources—including whatever is known about the disabled sub's location, depth and condition and the local weather forecast—to develop a U.S. rescue plan taking into account the most appropriate assets from around the world.

The same message that awakened you also alerted many other submarine rescue organizations that might be asked to provide support. Of the 43 countries that operate submarines, only about 15 maintain some submarine rescue capability. Only four air-transportable rescue systems have ever flown to a submarine rescue exercise. One, the small American Submarine Rescue Chamber Fly-away System (SRCFS), is not optimal for this mission, so that leaves three proven air-transportable systems with appropriate capabilities.

The SRDRS

The DSU's own Submarine Rescue Diving and Recompression System (SRDRS) can be transported by air and carried to a disabled submarine aboard a wide variety of military and civilian ships—referred to as “vessels of opportunity” (VOOs). The system's Pressurized Rescue Module (PRM) can evacuate up to 16 submariners at a time. However the SRDRS does not have what is called “transfer under pressure” (TUP) capability and it's not scheduled to receive it until 2013.

If the pressure inside a disabled sub has risen significantly due to seawater leakage, a gas leak or some other cause, rescued crewmembers

need to be kept in a hyperbaric chamber while the pressure is gradually reduced to normal. Until this is accomplished, exposure to normal atmospheric pressure can be life-threatening and requires supervision by a qualified undersea medical officer.

Without TUP capability, the SRDRS can't quickly move rescued submariners from the PRM to a hyperbaric chamber without sudden decompression, so it's not your first choice for rescuing the trapped submariners if another system that does have TUP capability can complete the rescue just as rapidly.

The NSRS

The crew of the NATO Submarine Rescue System (NSRS) have mustered at their base in Faslane, Scotland, and are preparing to deploy if asked. The NSRS is owned and operated jointly by France, Norway, and the United Kingdom. Like the SRDRS, it's specifically designed to be transported by air and operate from a VOO. In one submarine rescue exercise, two C-17s and three Antonov 124s transported the entire NSRS unit from Faslane to Bergen, Norway. Unlike the SRDRS, the NSRS does have TUP capability.

The NSRS has two major subsystems—called “intervention” and “rescue”—either of which can be deployed without the other. The intervention subsystem centers on the Intervention Remotely Operated Vehicle (IROV), designed to prepare a distressed submarine for rescue. The larger rescue subsystem consists of a free-swimming manned submersible rescue vehicle and its portable launch and recovery system, plus the TUP-capable decompression system and associated support equipment. While the footprint of this system is larger than that of the SRDRS, it currently has the world's only flyaway TUP capability.

The URF

The other proven alternative is Sweden's free-swimming URF—the Swedish initials for “submarine rescue vehicle.” The URF is the world's largest submarine rescue system, able to rescue all 35 crewmembers of a Swedish submarine in a single sortie—about the same number you need to rescue. The URF normally operates from a dedicated support ship, HSwMS *Belos*, which provides the system's TUP capability, but going by sea would take far too long.

Airlifting the 52-ton URF isn't easy, but it did conduct a successful air transportation test with an Antonov 124 aircraft in August

2001. Only a few VOOs can carry the URF, and none happens to be in the area, but the rescue vehicle's large battery capacity also allows it to be towed if the distance is short enough, and towing would avoid the time-consuming process of welding cranes or other large support structures to a VOO.

The URF's 40 hours of battery power leave 10 hours for towing from the port to the submarine, 10 hours to mate with the sub and take off her crew, and 10 hours for the return, with the last 10 hours held in reserve. That would be enough. However, the ISMERLO website shows that the URF is currently undergoing maintenance. Through the website, SUBDEVRON 5 confirms that it can't be made available in time.

The DSU moves out

While SUBDEVRON 5's casualty assistance team explores the options, the DSU, in San Diego has recalled all personnel. The operations officer and members of the contractor staff from Phoenix International, Inc., review airport and seaport options for getting the SRDRS to the stricken sub. Searching databases and contacting husbanding agents, the Phoenix personnel also locate a VOO in the area that has the space and weight-bearing capacity to carry the SRDRS.

The DSU prepares the SRDRS to move overseas and loads it onto five Air Force C-5 transports for airlift to an airport near the harbor where it will be loaded onto a VOO. (If C-5s were not available, the SRDRS could be airlifted in 12 of the smaller C-17 transports, and it is also compatible with some cargo versions of the Boeing 747 and the Russian Antonov 124.)

Of course, the equipment that each country sends must be compatible with the disabled sub. Ideally, it would also be compatible with equipment coming from other countries—which would not only help minimize TTFR, but also reduce the number of aircraft required—but that is less often the case. It's essential that all responding personnel be able to work closely together regardless of nationality. That's why the DSU and SUBDEVRON 5 regularly join with other countries in multinational submarine rescue exercises that help maintain proficiency in the difficult evolutions required for submarine rescue while building interoperability with other countries.

The largest multinational exercise is Bold Monarch, which takes place every three

years. The most recent one took place off the coast of Spain in June 2011, with even the Russian Navy providing a rescue system and a submarine. Another regular multinational exercise called Pacific Reach brought together participants or observers from 15 countries in the South China Sea in August 2010. The DSU also participates in CHILEMAR, a bilateral exercise with Chile that takes place off San Diego, most recently in November 2011.

Command relationships

Coordinating the rescue assets at the scene requires organization. If the disabled submarine were American, you, as CRF, would assume full responsibility for the rescue, overseeing development of the rescue plan, approving it, and tasking the rescue element commanders (RECs—for example, the commander of the SRDRS). Although you would report to an American on-scene commander, the on-scene commander would probably limit his involvement to providing support as needed, for example, by sanitizing the area and providing resources.

When the disabled sub isn't American, the OSC may not delegate as much responsibility to the CRF, since the OSC remains solely responsible to his own national authority for the effectiveness of the rescue—a responsibility you cannot share. As CRF, you are the OSC's principal advisor, and it's up to him to determine how much authority he delegates to you.

In addition to the RECs, any country providing rescue assets may also choose to assign a national rescue coordinator of higher rank to serve as that country's liaison with the CRF and OSC. However, that won't be necessary in this case. The REC commanding the multinational NSRS can provide all the liaison that system requires, and you are already serving as CRF, so there is no need for a national rescue coordinator to provide liaison for the American assets.

Coordinating the rescue

As CRF, you recommend that the on-scene commander request both the NSRS and SRDRS. These two systems have been used together before during a major exercise, and having both of them on hand will speed up the rescue.

ISMERLO provides tools for calculating an initial estimated time to first rescue for each participating rescue system, and these tools help your planners orchestrate



(Opposite) Sweden's URF, a large free-swimming submarine rescue vehicle. (Photo courtesy of Swedish Navy) (Above) The U.S. Navy's SRDRS operating from a vessel of opportunity. (Photo courtesy of DSU)

the roles of the participating systems so as to minimize TTFR. The estimated TTFR will continue to evolve as more information becomes available based on the actual situation. The San Diego-based SRDRS, which has less distance to fly in this case, is the first complete system to arrive, but the NSRS's intervention subsystem, which is designed to deploy separately six hours ahead of its rescue subsystem, gets there about the same time.

As a rule, the first system to arrive commences rescue operations as soon as possible, so if only one VOO were available when the SRDRS arrived, you would embark the SRDRS and let the NSRS, which is still en route, wait until another VOO arrives. Fortunately, two VOOs are available, so you can embark both the NSRS intervention capability and the SRDRS at the same time. For safety, you allow only one of them to dive on the sub at a time, a procedure demonstrated in the 2011 Bold Monarch exercise.

The NSRS intervention capability is first to leave port, so its ROV makes the first dive to pinpoint the boat's location on the bottom, conduct a preliminary damage assessment and make sure nothing is blocking the escape hatch. This makes it unnecessary for the SRDRS to deploy a diver in its Atmospheric Diving Suit (ADS) 2000, which can go as deep as 2,000 feet and has multiple thrusters to enhance maneuverability. You are now ready to deploy the PRM.

The rescue

The deployed PRM remains tethered to the VOO and is operated remotely from the surface, leaving the two internal attendants

who man it free to concentrate on monitoring the PRM atmosphere, operating the escape hatch and assisting the submariners. They find that the submarine is indeed pressurized, as is common for a damaged boat. In addition, some submariners are injured. The PRM transfers survival equipment and emergency supplies to the sub, then takes 16 submariners onboard, including some of the injured, who'll receive preliminary medical attention from the PRM's crew while returning to port. The PRM disengages from the submarine's escape hatch and heads for the VOO, completing the first rescue in just under the 72-hour goal.

Meanwhile, the other VOO has returned to port and embarked the NSRS rescue element. The NATO system's free-swimming submersible takes off the next 15 submariners a few hours later. They include a number of the more seriously injured who would be most at risk from an unpressurized transfer to a hyperbaric chamber, where medical specialists are standing by to treat them. Finally, the SRDRS, which has conducted an unpressurized transfer of the first group of sailors to a hyperbaric chamber under the strictest medical supervision, returns to evacuate the last few crewmembers, completing the rescue. All that remains is decompression of the rescued submariners, a process that will take several days under the careful supervision of qualified divers.

Capt. Osen recently completed a tour of duty as chief of staff of the U.S. Navy's submarine rescue reserve component. He is now commanding officer of Naval Reserve Undersea Warfare Operations Detachment A.

No Rain on *California's* Parade

Commissioning Stays Dry in Helo Hangar

USS *California* (SSN 781), the Navy's newest attack submarine, joined the fleet Oct. 29 in a ceremony at Naval Station Norfolk in Norfolk, Va. *California* is the eighth boat of the *Virginia* class and seventh Navy ship to carry the name of the "Golden State." California Congressman Howard P. "Buck" McKeon, chairman of the House Armed Services Committee, was the keynote speaker. Donna Willard, *California's* sponsor and wife of Commander, U.S. Pacific Command, Adm. Robert F. Willard, gave the traditional order, "Man our ship and bring her to life!"

Unfortunately, the crew couldn't actually man the ship. Frigid temperatures and rain moved the commissioning inside the warm and dry hangar of Helicopter Mine Counter-Measure Squadron 15, where over 1,500 distinguished guests, family and friends welcomed *California*. But the *California* family did not let the weather ruin their day. Chief of Naval Operations Adm. Jonathan Greenert even joked that the audience might think the missing sub was just the Navy's way of taking stealth to a whole different level.

California began construction on Feb. 16, 2010. Her keel was laid on May 1, 2009, and her christening occurred on Nov. 6, 2010. The Navy accepted delivery of *California* on Aug. 7, 2011, nearly nine months earlier than her scheduled contract delivery date. "Not only was the ship early, under budget, and more



Photo by Petty Officer 2nd Class Shannon E. Renfro

complete than her predecessors," said Rear Adm. David Johnson, Program Executive Officer for Submarines, "She was also more deployment-ready right out of new construction, a testament to the capability resident in our world's best Navy-industry team."

The Navy-industry team proved their capabilities again in September 2011, when construction began on the 13th *Virginia*-class submarine, the unnamed SSN 787, marking the first time in 22 years that two submarines of the same class have started construction in the same year. "The com-

missioning of PCU *California* (SSN 781) represents a tipping point, as the *Virginia*-class will now comprise 15 percent of our attack submarine force," said Commander, Submarine Group Two, Rear Adm. Rick Breckenridge, in a blog post prior to the commissioning. "The highly successful *Virginia*-class shipbuilding program ... has become the model for the rest of the Navy."

Although *California* was built across the country from her namesake state, her connections to the state are strong. During the commissioning, Dr. Joseph Cox, a California native for over 75 years, was given the privilege of passing the ceremonial "long glass" to *California's* first officer of the deck to signify the start of the first watch. Dr. Cox is a World War II veteran who served aboard USS *Batfish* (SS 310) and a former national president of the U.S. Submarine Veterans Organization.

Twelve crewmembers from California are assigned to the submarine, including Petty Officer 3rd Class Tariq Sharif, from Los Angeles, who originally chose a submarine billet hoping he would end up in California. While Sharif's assignment did not exactly go as hoped, he is proud to be a part of *California's* crew: "Well if I can't be home, at least I'll be attached to a boat that has my home name."

The *California* crew held a competition in 2009 to design the boat's logo. *California* Petty Officer 1st Class David Henley notified



Photo by Petty Officer 2nd Class Eric C. Tretter



Photo by Petty Officer 2nd Class Eric C. Tretter

(Opposite, top) *California* Sailors rush to symbolically “man their ship and bring her to life.” (Opposite, bottom) Chief of Naval Operations Adm. Jonathan Greenert greets a Sailor aboard *California* after the commissioning ceremony. (Above, left) *California* Commanding Officer Cmdr. Dana Nelson, sponsor Donna Willard, and Chief of the Boat Master Chief Kevin Bond. (Above, right) Rep. Howard “Buck” McKeon delivers remarks during the commissioning ceremony. (Below) *California*’s logo, designed by Ken Henley, father of a *California* Sailor. (Bottom) World War II submarine veteran Dr. Joseph Cox passes the long glass to set *California*’s first watch.

his father, Ken Henley, of the contest. Henley, who lives near Nashville, Tenn., had the winning design. “Seven stars represent the seven previous vessels named after California,” said Henley, and “the Grizzly Bear is the state animal that shows strength.” He also included the state’s colors, blue and gold, representing the sunny blue sky for which it is famous and the 1849 gold rush. Also on the crest is *California*’s motto, “Silentium Est Aureum,” Latin for “Silence is Golden.”

The commissioning was anything but silent, as attendees erupted in applause and rose to their feet on several occasions in recognition of *California*, her crew, and her sponsor, Donna Willard. “She has been very hands on, to say the least, and not just for these ceremonial events,” said Matt Mulherin, Newport News Shipbuilding president. “She has visited our shipyard numerous times to keep tabs on ‘her boat.’ In fact, she has her very own hard hat and steel-toed shoes that we keep at the ready.” Turning to Mrs. Willard, Mulherin added, “Many of us were expecting to see you underway on sea trials.”

Rep. McKeon commended the crew in his speech. “This wonderful vessel is a feat of American engineering and innovation,” he said. “But without you men, it is simply a lump of wire and steel. A submarine does not have courage, or cunning, or determination; it’s the crew that will be *California*’s brain,



Photo by Olivia Logan

muscle, and life blood. You are the soul of this vessel.”

Cmdr. Dana Nelson, *California*’s commanding officer, praised his crew for a job well done. “As you can probably tell, I’m proud of my great ship,” said Cmdr. Nelson. “But at least to me, she pales in comparison to the 136 young men standing in front of me. Team, your performance over the last 36 months has been spectacular. Talented, hard-working, resilient, you are shining examples of all that is right with America.”

Rear Adm. Breckenridge ended his blog post with some insight on *California*’s future. “‘Silence is Golden’ is a fitting motto to the *California* and her crew, as they are tasked to slip behind enemy lines and employ the most advanced stealth, sensors, and ship control systems known to man,” said Adm. Breckenridge. “But it will be *California*’s ‘grizzly growl’—her lethal weapons and advanced payloads—that will deter aggression and promote regional stability.”

California spent most of November and December 2011 underway for training and building operational proficiency. In January 2012, she traveled to her homeport of Groton, Conn., for a post-shakedown availability. *California* will be ready for her first operational deployment in 2014.

Olivia Logan is the managing editor of UNDERSEA WARFARE Magazine.

Christmas came early for the Navy's newest attack submarine, PCU *Mississippi* (SSN 782). The ninth submarine of the *Virginia* class celebrated her christening on Dec. 3, 2011, at General Dynamics Electric Boat in Groton, Conn. Electric Boat President John Casey presided at the late-morning ceremony on *Mississippi's* deck, with the Thames River gleaming in the background beneath a cloudless late-autumn sky.

Secretary of the Navy Ray Mabus was the principal speaker. A native of Ackerman, Miss., who was elected in 1987 as Mississippi's youngest governor in more than 100 years, Mabus said it is no accident that this is the fifth ship to bear his home state's name. "The long history of naming ships *Mississippi* is a testament to the state's history in shipbuilding and to the resilience, the patriotism and the strength of the people of Mississippi."

Mississippi began construction on Feb. 18, 2007, with keel authentication occurring June 9, 2010, and pressure hull completion in April 2011. She is the first submarine to be named after the nation's 20th state, which is named after the Mississippi River and known as the "Magnolia state."

"Mississippi" is a Native American word meaning roughly "Father of Waters," certainly an appropriate name for a submarine. The state motto—which is now the ship's motto as well—is equally appropriate: "Virtute et Armis" is Latin for "By Valor and Arms." Vice Adm. John Richardson pointed out that this is "a true warrior salutation; something said before going into battle."

Mississippi will be battle-ready earlier than previous ships of her class. At her christening,



Crisp Air and Clear Skies for Christening of PCU *Mississippi*

she was 97 percent complete and scheduled to be delivered about a year ahead of schedule—and over 50 million dollars below the contracted cost—a testament to the work ethic of the crew, the shipbuilders, and the industrial base. "The ship before you is the product of a team defined by a commitment to innovation, quality and execution excellence," said Casey. "This team is truly a singular group, comprising

the most dedicated, capable and talented people I know."

An example of the shipbuilders' innovation is a group of 50 Electric Boat employees, nicknamed the "Steam Team," who used a new technique to test the flow of steam in the engine room before the submarine was in the water. Electric Boat leased a large boiler to create the steam needed to test pipes and valves and run the





Photo by Olivia Logan



Photo by Petty Officer 1st Class Virginia K. Schaefer

(Opposite, top) Ship sponsor Allison Stiller christens *Mississippi* by breaking a bottle of sparkling wine against the sub. (Opposite, bottom) Sailors assigned to PCU *Mississippi* file off the ship after the conclusion of the christening ceremony. (Above, left) Vice Adm. John Richardson, Commander, Submarine Forces, speaks at PCU *Mississippi*'s christening. (Above, right) (from left to right) Lt. Cmdr. Daniel Reiss, *Mississippi*'s Executive Officer, Capt. John McGrath, commanding officer, and Master Chief William Stoiber, chief of the boat, listen to remarks during the boat's christening ceremony.

generators that produce electricity while *Mississippi* remained on the blocks in the main building shed. This new procedure shortened *Mississippi*'s construction time by a month because it is easier to work on her while she is still on land.

Electric Boat plans to buy the boiler and use it for future submarines, a move that would save the *Virginia*-class program \$24 million. "It's a smart investment," said Rear Adm. David Johnson, Program Executive Officer for Submarines. "We both share in the reduced cost of that ship, and the Submarine Force community gets the ship that much earlier."

Mississippi's sponsor, Deputy Assistant Secretary of the Navy for Ship Programs Allison Stiller, broke the traditional bottle of sparkling wine against the submarine. *Mississippi* is unique in having a sponsor who has worked professionally with submarines since 1985, supporting the *Trident*, *Seawolf* and *Virginia* classes. *Mississippi*'s christening marked the 38th time Stiller has attended a ship christening, proof of her longstanding commitment to Navy shipbuilding.

Rep. Joe Courtney, of Connecticut's 2nd District—known in the submarine and

political community as "Two-Subs Joe," for his push for a production rate of two submarines per year—praised Stiller's public service in her current job. "As a member of the House Armed Services Committee, I've had the opportunity to watch Allison perform her duties as deputy assistant secretary of the Navy," he said. "She is smart, knowledgeable, completely ethical, and committed to ensuring that the taxpayer receives the best value for public investment in Navy shipbuilding."

As if *Mississippi* didn't have enough to celebrate, Chief of Naval Operations Adm. Jonathan Greenert awarded her crew the 2011 Navy Community Service/Project Good Neighbor award in the small sea command category two days prior to her christening.

"I'm so proud of the crew of PCU *Mississippi* for this important achievement," said the ship's commanding officer, Capt. John McGrath, who leads a crew of about 142 officers and enlisted personnel. "In addition to their shipboard duties, our dedicated volunteers donated over 90 hours of cumulative community service per month since 2010." Capt. McGrath was also celebrating his promotion to captain, which took place Dec. 1.

There is still a lot to accomplish before *Mississippi* is ready to join the fleet. "We will be loading out the ship with stowage, finishing all of the living spaces, making the ship habitable, and moving the crew aboard," said Harry Haugeto, the Electric Boat manager for *Mississippi*. "In parallel, we will be finishing up the testing and turning over operational control of the remaining systems to the crew."

Once complete, *Mississippi* will proceed with sea trials. When contractual requirements are met and the Navy Board of Inspection and Survey is satisfied, she will be delivered to the Navy. Her commissioning is scheduled to take place in June, in Pascagoula, Miss.

"Today is a day to celebrate," commented Matt Mulherin, President of Newport News Shipbuilding, Electric Boat's partner in building *Mississippi*. "Tomorrow we go back to work and back to building history."

Olivia Logan is the managing editor of UNDERSEA WARFARE Magazine.

THE HARD LESSONS OF

WORLD WAR II TORPEDO FAILURES

U.S. Navy photo courtesy of Norman Polmar

The torpedo failures that American submariners suffered in World War II are rightly infamous, but that experience was not unique to America. Even Germany, the leading submarine power for most of the war, suffered failures just as devastating.

Submarines became Germany's principal naval force in World War I. With the battle-ships of Imperial Germany's High Seas Fleet unable to break the blockade imposed by Britain's Royal Navy, the Germans resorted to unrestricted submarine warfare in an attempt to strangle Britain's commerce and knock her out of the war. They nearly succeeded. Armed with relatively simple torpedoes, the U-boats sank millions of tons of Allied shipping before the Royal Navy and the U.S. Navy managed to defeat them with convoys.

German Torpedoes

After the war, the victorious Allies abolished the German submarine force, but they

could not prevent German submariners from developing new technology. Despite extremely tight budgets, the submariners secretly commissioned designs for improved U-boats and sponsored the development of advanced torpedoes. These covert initiatives bore fruit in the wake of the 1935 Anglo-German Naval Treaty, which allowed Germany to begin rebuilding its submarine force.

Germany entered World War II with two state-of-the-art submarine torpedoes: a traditional "steam" torpedo powered by a mixture of air, water and liquid fuel; and the world's first operational electric torpedo, which left no wake to alert the target or reveal the U-boat's location. Both torpedoes had a warhead larger than those of World War I, and both had a "magnetic pistol" detonator activated by a target ship's magnetic field. The new detonator was designed to explode the warhead just as the torpedo passed beneath the keel. Adm. Karl Dönitz, who

led Germany's pre-war submarine buildup, was confident this new form of attack would prove devastating.

Loss of Confidence

The first doubts about the effectiveness of German torpedoes cropped up early in September 1939, the first month of the war. U-39 got a good set-up on the British aircraft carrier *Ark Royal*, launched three torpedoes, and went deep. Hearing three well-timed explosions, the crew assumed three hits, but U-boat headquarters soon learned that *Ark Royal* was still operating and concluded that the magnetic influence detonator had activated prematurely. Not long afterwards, another U-boat visually observed several "prematures."

Dönitz referred the matter to the Torpedo Directorate, which recommended resetting the detonator to reduce its sensitivity. Despite further adjustments, reports

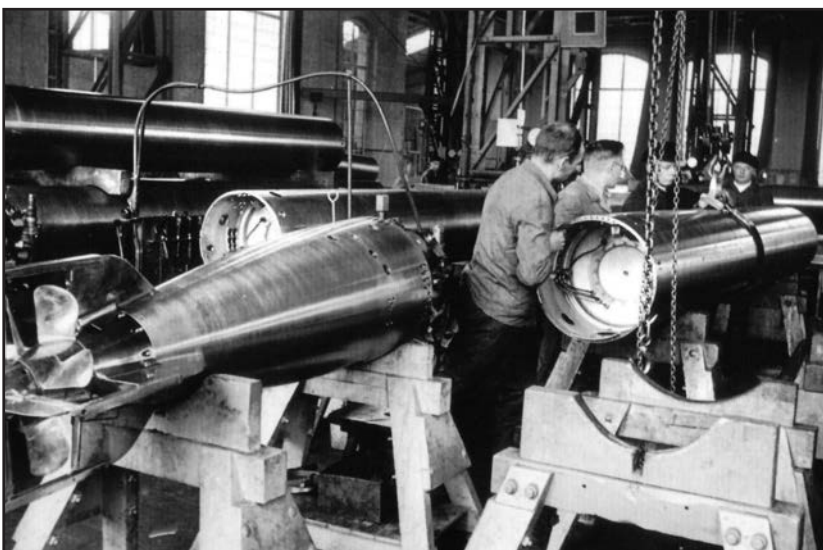
of prematures continued, including two cases of explosions close enough to endanger the launching boat. Yet some torpedoes, like those that sank the British carrier *Courageous*, seemed to work fine. With many sub crews still green, the Directorate attributed most failures to poor maintenance or poor shooting.

However, 13 U-boat commanders, including some of the best, reported malfunctions in the war's first month, leading Dönitz to conclude that crew errors could not explain all of the failures. He prevailed on the naval high command to order

a technical investigation. The Torpedo Directorate found a wiring flaw in the influence detonator and signs of a mechanical defect in the steam torpedoes that could not yet be isolated. The wiring was fixed. In the steam torpedoes, the influence detonator was disconnected, leaving only the impact detonator. But in October, the war's second month, one boat reported no less than seven torpedo malfunctions in a single engagement. Acting on his own authority, Dönitz, on Oct. 18, ordered his boats to cease using the obviously defective influence detonator altogether.

Many U-boat commanders suspected that torpedoes were running too deep. The Torpedo Directorate had known for some time that torpedoes were running six-and-a-half feet deeper than intended because the exercise heads used for calibration were more buoyant than warheads. Directorate officials thought this would make no difference with the influence detonator, but as soon as they learned that the U-boats would be using only impact detonators, which required more precise depth-keeping, they notified the submariners of the problem.

Dönitz then received a report from a boat in the Mediterranean that four impact detonators failed in an attack on a stationary ship under ideal conditions. The high command ordered another technical investigation, and on Nov. 10, Dönitz directed all boats to use a supposedly improved version of the influence detonator. Later that month, a boat reported that three steam torpedoes with



(Opposite) A Mk 10 torpedo fitted with a Mark 6 magnetic influence detonator passes under the target, a decommissioned submarine, without exploding in the first of only two live-fire tests of the Mark 6. (Above) German G7a "steam" torpedoes being repaired in 1940. (Photo courtesy of Établissement de Communication et de Production Audiovisuelle de la Défense, Paris, France).

influence detonators had prematured—two close aboard—and one electric torpedo failed to detonate. Another boat tallied nine failures in 11 launches.

"The torpedo," Dönitz bitterly concluded, "can no longer be regarded as a front-line weapon of any use."

Fixing the Problems

Having lost confidence in the torpedo establishment, the German Navy replaced the head of the Torpedo Directorate and appointed an outside civilian engineer to control all torpedo work, including badly lagging production. The new leadership quickly identified several technical defects, but fixing them would take time.

In March 1940, Hitler ordered most available U-boats to Norwegian waters to intercept an anticipated Franco-British occupation force. The Germans invaded Norway on Apr. 9. Convoys carrying the Allied troops began to arrive soon afterwards, but the U-boats lurking offshore missed one opportunity after another to sink Allied ships. Subsequent analysis indicated that defective torpedoes prevented them from scoring hits in at least one attack on a battleship, seven attacks on cruisers, seven on destroyers, and five on transports.

On May 1, the torpedo experts announced a high failure rate in tests of the "clumsy" and unnecessarily complex impact detonator, whose defects had gone undetected due to inadequate prewar testing. On May 5, the Germans captured a British submarine

complete with torpedoes, and the Torpedo Directorate agreed to copy the superior British impact detonators. Later in May, continued problems with supposedly improved influence detonators led Dönitz to forbid their use until all their problems were unquestionably solved, which would not happen until much later in the war. However, starting in June 1940—the war's tenth month—sinkings with the new impact detonator rose dramatically.

One problem remained undetected until America entered

the war in December 1941. U-boats that made the long transit to attack shipping along the U.S. East Coast began to experience numerous electric torpedo failures. On Jan. 30, 1942, a young skipper reported that while ventilating electric torpedoes onboard, his crew discovered leakage into the balance chamber housing the torpedoes' depth-setting equipment, which caused a pressure increase that could make them run deeper than set. The Torpedo Directorate confirmed the problem, which tended to worsen during long periods at sea, and recommended successful fixes.

Thus, nearly two and a half years into the war, the saga of German torpedo malfunctions came to a close just as American submariners were discovering similar failings in their own torpedoes. Like the German problems, the failings of American torpedoes stemmed from poor or unproven designs whose problems went undetected due to inadequate technical and operational testing.

American Torpedoes

Unlike the Germans, the Americans lacked combat experience with torpedoes. By the time America entered World War I, the primary naval mission was protecting Allied shipping from German torpedoes. Only 11 U.S. torpedoes were fired in anger, all of which either missed or were aimed at phantom targets.

Still, American submariners had confidence in their torpedoes. The Navy's World War I-era "S-boats" used the Mark 10 steam tor-

pedo, an impact weapon of proven reliability. For the more modern boats that eventually followed, the Torpedo Station at Newport, R.I., developed the much more capable Mark 14 steam torpedo, which could use either an impact detonator or the new, top-secret Mark 6 magnetic influence detonator.

However, funding was very scarce during the 1920s and 1930s, so the Mark 14 and the Mark 6 detonator were developed and tested on a shoestring budget. The Torpedo Station conducted only one test using live warheads, with hand-built Mark 6 detonator prototypes installed in old Mark 10 torpedoes. In two shots on the Newport test range using a decommissioned submarine as the target, one torpedo passed beneath without exploding, apparently running too deep, but the other exploded below the keel, quickly sinking the sub.

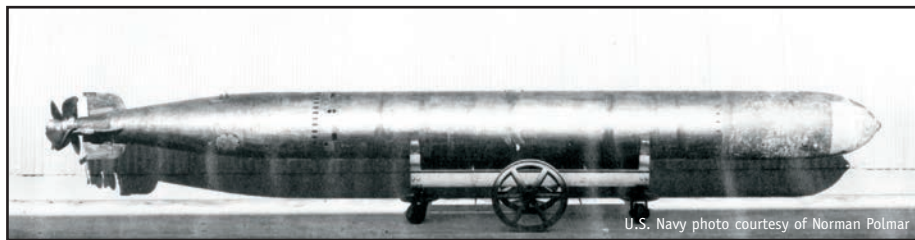
Subsequent tests at sea near the equator seemed to demonstrate that the detonator performed as designed regardless of variations in the earth's magnetic field. However, the cruiser used as a target was an operational warship, so the test torpedoes carried only exercise heads. Instead of an explosion, a photoelectric sensor called an "electric eye" activated a film camera to record the shadow of the target's hull as the torpedo passed beneath, and the detonator ignited a small amount of guncotton to show it was activated by the ship's magnetic field.

The influence detonator went into production with no additional testing. To ensure that it remained a closely guarded secret, the Mark 14 torpedo entered service with only the impact detonator installed. Not until the summer of 1941 were the first fleet boat crews introduced to the Mark 6 detonator and told that it would enable them to sink a ship with a single torpedo.

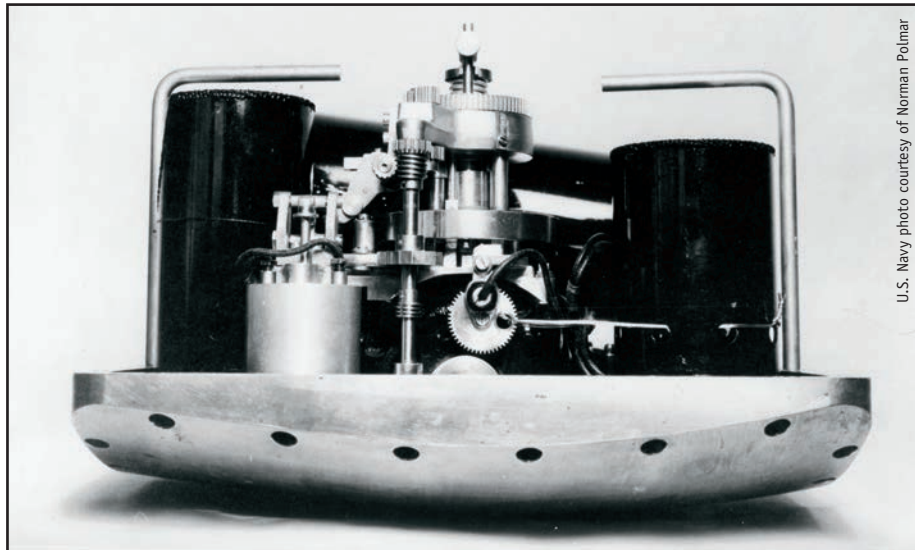
Ignoring the Failures

Once hostilities began, American submarine commanders encountered the same problems as the Germans: premature detonation, failure to detonate, and running too deep. Some skippers took great pains and incurred great risks to investigate and document these problems during war patrols—to no avail. Unlike the German submarine leadership, American shore-based commanders had no combat experience and felt little solidarity with their embattled skippers.

Before the war, the American submarine service had demanded excessive caution from its skippers. As a result, higher-level



U.S. Navy photo courtesy of Norman Polmar



U.S. Navy photo courtesy of Norman Polmar

(Top) The Mark 14 was the only torpedo carried by U.S. fleet boats when the Japanese attacked Pearl Harbor on Dec. 7, 1941. (Bottom) The Mk 6, Mod 1 magnetic influence detonator, photographed at the U.S. Naval Torpedo Station, Newport, R.I.

commanders had to weed out timid, unproductive skippers in the early days of the war. Driving their sea-going subordinates to achieve results, shore-based commanders persistently dismissed complaints about malfunctioning torpedoes and blamed skippers and their crews for failing to get hits. Occasionally, someone might refer a complaint to the Bureau of Ordnance (BUORD) and the Torpedo Station, but these organizations invariably concurred with the operational leadership in blaming the failures on poor shipboard maintenance or faulty combat procedure.

Correcting the Depth Problem

The first problem to get addressed was excessive depth. Pre-war tests at the Torpedo Station indicated the Mark 10 and Mark 14 both ran four feet too deep because of calibrating with exercise heads, but submariners in the Far East were not informed until nearly a month after Pearl Harbor. After assuming command of U.S. submarines based in Fremantle, Australia, in May 1942, Rear Adm. Charles Lockwood, decided to conduct his own tests. A series of realistic trials in June and July revealed that the Mark 14 ran an average of 11 feet below the depth setting.

The Torpedo Station not only failed to account for the different buoyancies of exercise heads and warheads, it also neglected to simulate combat launch conditions or allow for the deterioration of depth control apparatus over time. It even failed to check torpedo performance against an absolute standard, relying instead on test sensors installed in the torpedoes themselves, which merely echoed the incorrect readings of the weapons' own depth and roll sensors. Not until August 1942, eight months after Pearl Harbor, did BUORD determine that the torpedoes were running about 10 feet too deep and issue instructions to solve the problem.

Meanwhile, the first defect of the impact detonator was detected and resolved in the spring of 1942. To prevent the explosion of one torpedo in a spread from prematurely detonating another, the detonator included a diaphragm that, when subjected to the pressure of a shock wave, drove a small pin into the firing mechanism, blocking detonation. But the diaphragm was far too sensitive, so even normal water pressure at periscope depth could drive in the pin. The solution was simply to disconnect the pressure override.

Eliminating the Magnetic Influence Detonator

By February 1943, when Rear Adm. Lockwood took command of the Hawaii-based submarines under Pacific Fleet Commander-in-Chief Adm. Chester Nimitz, complaints about the Mark 6 influence detonator had become so strident that even BUORD was having second thoughts. However, the Bureau incorrectly concluded that the malfunctions were caused by variations in the earth's magnetic field, so its recommendations, issued May 7, proved ineffective.

Frustrated by clear evidence of Mark 6 malfunctions in decoded Japanese communications, Lockwood took the bull by the horns and persuaded Nimitz to order the Mark 6 disconnected for good. Nimitz's order, however, did not apply to the submarines based in Australia, which were part of the Seventh Fleet, reporting to Gen. Douglas MacArthur. The commander of those submarines, Rear Adm. Ralph Christie, was an MIT-trained engineer who had been personally involved in developing the Mark 6. Christie continued to insist that his boats use the flawed detonator right up to the end of 1943, when a new Seventh Fleet commander finally ordered it deactivated.

The Last Problem

Elimination of the influence detonator exposed grave defects in the impact detonator. On July 24, 1943, yet another skipper went to great lengths to document torpedo failures, systematically firing torpedo after torpedo at the same tanker under near-perfect conditions until he had recorded 11 hits with no effect. Lockwood then authorized the experimental firing of impact torpedoes against a Hawaiian cliff face, which began on Aug. 11.

Examination of the first failed torpedo revealed that the fragile detonator mechanism, distorted by the impact, prevented the firing pin from striking with sufficient force to initiate an explosion. Subsequent drop tests on land with dummy warheads showed that a perfect hit at 90 degrees crushed the detonator and prevented it from working, whereas a glancing blow at 45 degrees left it sufficiently intact to set off an explosion. Twenty-one months after Pearl Harbor, the last major torpedo malfunction was finally identified. While the fleet made interim fixes, the Torpedo Station conducted follow-up tests and ordered a redesign.

Remembering the Lessons

America and Germany learned the hard way that torpedoes are finicky weapons that cannot tolerate shortcuts. The most complex naval weapons of World War II, they demanded meticulous design, rigorous testing and intensive maintenance—not to mention exacting targeting and launch procedures. Lack of rigor at any stage from initial design to the torpedo's use in combat could result in failure, and the many opportunities for mistakes made it hard to tell where the fault lay, even after the weapon's poor performance became obvious.

Seen in this light, German and American torpedo failures are quite understandable. Only in hindsight is it apparent that the more complicated torpedoes developed for World War II demanded an unprecedented level of technical and operational evaluation. And even Germany's veteran submarine leaders never thought to second-guess their Torpedo Directorate until the problems became obvious.

Germany fixed most of her torpedo problems in less than half the time it took the United States because her submarine leadership was more experienced and because submarines were the mainstay of her navy. Doenitz and his staff knew from the start how to establish a trusting relationship with U-boat skippers and how to evaluate their reports. Senior American submariners had

to learn those skills on the job. U-boats took the lead in Germany's naval war, while American submarines played second fiddle to battleships before Pearl Harbor and to aircraft carriers afterwards. If U.S. carriers had lost the Battle of Midway because their bombs failed to explode, it's safe to say the problem would have gotten a lot more attention than torpedo failures did.

Fortunately, American submariners and their technical establishment took the torpedo failures very much to heart. The rigorous testing program established after the war continues to ensure the reliability and effectiveness of U.S. torpedoes to this day. The need for excellence in all aspects of torpedo development and handling—above all in technical and operational evaluation—has never been greater than it is now, and as budget constraints loom once more, the need to bear in mind the bitter lessons of World War II has never been clearer.

Anyone interested in learning more can begin with the three sources used for this article: *Hitler's U-Boat War, the Hunters, 1939-1942*, by Clay Blair; Blair's monumental *Silent Victory, the U.S. Submarine War against Japan*; and *Ship Killers, a History of the American Torpedo*, by Thomas Wildenberg and Norman Polmar. (U.S. Navy photos used in this article are from *Ship Killers*.)

Mr. Patrick is UNDERSEA WARFARE Magazine's senior editor.

A German G7e electric torpedo on display at the Naval Undersea Museum in Keyport, Wash. U-boats carried both the pioneering wakeless G7e and the G7a steam torpedo from the outset of World War II.



Photo courtesy of Naval Undersea Museum

USS Ohio Celebrates 30 Years in the Fleet

USS *Ohio* (SSGN 726) celebrated her 30th birthday Nov. 11—three decades after initiating a new era in U.S. strategic deterrence as the first of 18 Trident submarines designed to carry the first submarine-launched ballistic missile with intercontinental range.

The *Ohio* class was conceived in the early 1970s to succeed the original group of 41 SSBNs—the famed “41 For Freedom”—commissioned between 1959 and 1967. Scheduled to be decommissioned in the early 2000s due to strategic arms treaty limitations, *Ohio* instead became the first SSBN converted to carry Tomahawk Land Attack Missiles and special operations personnel and equipment.

Ohio completed her conversion and rejoined the fleet on Feb. 7, 2006. A year later, she proceeded to Guam to begin the first SSGN forward deployment, blazing a new path in the areas of special operations and global strike.



Photo by Petty Officer 2nd Class Clifford L. H. Davis

USS *Ohio* as SSGN 726

Change of Command

COMSUBGRU 10

Rear Adm. Joseph E. Tofalo relieved
Rear Adm. Barry L. Bruner

COMSUBRON 16

Capt. Stephen M. Gillespie relieved
Capt. Tracy Howard

Naval Submarine Support Center

Cmdr. Gregory McRae relieved
Cmdr. Daniel Way

Strategic and Attack Submarines Program (PMS 392)

Capt. Michael E. Elmstrom relieved
Capt. Kenneth R. Sault

Undersea Defensive Warfare Systems Program (PMS 415)

Capt. Moises DelToro relieved
Capt. David C. Knapp

Submarine Imaging and Electronic Warfare Program (PMS 435)

Capt. Steve Debus relieved
Capt. Lorin Selby

1120 Acquisition Community Manager

Capt. John Zimmerman relieved
Capt. Moises DelToro

USS Norfolk (SSN 714)

Cmdr. Gregory M. Zettler relieved
Cmdr. Douglas A. Jordan

USS Michigan (SSGN 727) (G)

Capt. Robert V. James III relieved
Capt. Philip G. McLaughlin

USS Alaska (SSBN 732) (G)

Cmdr. Robert Wirth relieved
Cmdr. Cory Jackson

USS Tennessee (SSGN 734)

Cmdr. Brett Moyes assumed command of Tennessee Blue
Cmdr. Richard Dubnansky assumed command of Tennessee Gold

USS West Virginia (SSBN 736)

Cmdr. Adam Palmer relieved
Cmdr. Steven Hall

USS Kentucky (SSBN 737)

Cmdr. Gerhard A. Somlai relieved
Cmdr. Joseph Nosse

USS Rhode Island (SSBN 740) (G)

Cmdr. Sean Muth relieved
Cmdr. Kevin Mooney

USS Wyoming (SSBN 742) (B)

Cmdr. Barry Rodrigues relieved
Cmdr. Bill McKinney

USS Louisiana (SSBN 743) (B)

Cmdr. Paul Varnadore relieved
Cmdr. Eric Woelper

USS Columbus (SSN 762)

Cmdr. David Youtt relieved
Cmdr. David Minyard

USS Hartford (SSN 768)

Cmdr. Steven Wilkinson relieved
Cmdr. Robert Dunn

USS Connecticut (SSN 722)

Cmdr. Ian L. Johnson relieved
Capt. Benjamin J. Pearson III

USS Emory S. Land (AS 39)

Capt. Paul E. Savage relieved
Capt. Thomas P. Stanley

Qualified for Command

Lt. Cmdr. Steven Dawley
USS City of Corpus Christi (SSN 705)

Lt. Cmdr. Jeffrey Fassbender
COMSUBRON 15

Lt. Cmdr. William Harley
COMSUBRON 17

Lt. Cmdr. John Hodges
COMSUBRON 7

Lt. Cmdr. Edwin E. Ostroot
COMSUBRON 16

Lt. Cmdr. Michael A. Paisant
Submarine Learning Center Norfolk

Lt. Cmdr. Chimi Zacot
COMSUBRON 1

Lt. Terry Hamer
COMSUBRON 19

Lt. Dennis J. Milsom
COMSUBRON 16

Lt. Andrew Simons
COMSUBRON 15

Qualified Nuclear Engineer Officer

Lt. Kerry Armes
USS Hawaii (SSN 776)

Lt. Jason Carroll
USS Jefferson City (SSN 759)

Lt. Robey Clark
USS Santa Fe (SSN 763)

Lt. Orin Council
USS City of Corpus Christi (SSN 705)

Lt. Haley Dodson
USS Columbus (SSN 762)

Lt. Eric Dridge
USS San Francisco (SSN 711)

Lt. David Drinan
USS Pasadena (SSN 752)

Lt. Paul Galatro
USS Pasadena (SSN 752)

Lt. Chad Guillerault
USS Nebraska (SSBN 739) (G)

Lt. Benjamin Kohn
USS Maine (SSBN 741) (B)

Lt. Daniel Kohnen
USS Columbus (SSN 762)

Lt. Adrian Lai
USS Chicago (SSN 721)

Lt. Robert Lee
USS Columbia (SSN 771)

Lt. Scott Miller
USS Hampton (SSN 767)

Lt. Josh Nickerson
USS Henry M. Jackson (SSBN 730) (B)

Lt. James Pearson
USS Seawolf (SSN 21)

Lt. Eric Radspinner
USS Key West (SSN 722)

Lt. Aaron Troy
USS Henry M. Jackson (SSBN 730) (G)

Lt. Nathan Voelker
USS Nevada (SSBN 733) (B)

Lt. Christopher Wood
USS Kentucky (SSBN 737) (G)

Lt. j.g. Travis Albright
USS North Carolina (SSN 777)

Lt. j.g. Richard Ali
USS Hampton (SSN 767)



Photo by Petty Officer 2nd Class Daine Doucett

USS *Miami* Holds Pinning Ceremony on Historic British Warship

Britain's Royal Navy hosted a pinning ceremony for USS *Miami* (SSN 755) Sailors aboard the historic ship HMS *Victory*. *Miami* Commanding Officer Cmdr. Roger E. Meyer presided at the Nov. 30 ceremony, in which five crewmembers received their dolphins and eight advanced to the rank of Petty Officer 3rd Class.

Victory is the oldest commissioned warship in the world and the only surviving wooden battleship from the age of sail. She is most famous for serving as British Adm. Horatio Nelson's flagship in the historic 1805 Battle of Trafalgar.

"I can't help but recognize how fortunate we are to advance eight young Sailors to Petty Officer 3rd Class aboard HMS *Victory*, a ship rich in history, and once commanded by a great British Naval leader," said Cmdr. Meyer.

Sub Skipper Receives Stockdale Award

Chief of Naval Operations Adm. John Greenert awarded the Atlantic Fleet's Vice Adm. James Bond Stockdale Award for Inspirational Leadership to Cmdr. Gerald Miranda, commanding officer of USS *Asheville* (SSN 758), in a ceremony at the Pentagon Jan. 5. Cmdr. Robert B. Chadwick, deputy executive assistant to the vice chief of naval operations, was the Pacific Fleet award winner.

The annual award is presented to two commissioned officers, one each from the Atlantic and Pacific Fleets, who are on active duty below the grade of captain and in command of a single ship, submarine, aviation squadron, or other operational warfare unit. Candidates are nominated by peers and recommended by fleet commanders for consideration by a panel of senior officers. The award was established in honor of Vice Adm. James Bond Stockdale, whose distinguished naval career symbolizes the highest standards of excellence in both personal example and leadership.

"How it came to be that I was chosen among a field of so many fine commanding officers is truly unbelievable," said Cmdr. Miranda. "Although my name is on the plaque, it's really a crew award. Without my courageous and dedicated crew, this recognition would not be possible. Each and every Sailor onboard shares in this award's prestige; they are a group of ordinary men doing extraordinary things."



Photo by Petty Officer 3rd Class Shannon Burns

Lt. j.g. Garrett Allen
USS Henry M. Jackson (SSBN 730) (G)

Lt. j.g. Gregory Andrew
USS Hampton (SSN 767)

Lt. j.g. Christopher Andrews
USS Jimmy Carter (SSN 23)

Lt. j.g. Samuel Beck
USS Louisiana (SSBN 743) (G)

Lt. j.g. Zachary Buzzatto
USS Louisville (SSN 724)

Lt. j.g. Patrick Cerone
USS Nebraska (SSBN 739) (G)

Lt. j.g. Andrew Clingman
USS La Jolla (SSN 701)

Lt. j.g. Evan DiPetrillo
USS Greenville (SSN 772)

Lt. j.g. Matthew Gieszl
USS Jacksonville (SSN 699)

Lt. j.g. Daniel Goodwin
USS Greenville (SSN 772)

Lt. j.g. Ryan Grundt
USS Charlotte (SSN 766)

Lt. j.g. Allan Hale
USS Michigan (SSGN 727) (G)

Lt. j.g. John Hartsog
USS Charlotte (SSN 766)

Lt. j.g. Donald Head
USS Michigan (SSGN 727) (B)

Lt. j.g. Kevin Henderson
USS Ohio (SSGN 726) (G)

Lt. j.g. Jason Hovey
USS Connecticut (SSN 22)

Lt. j.g. Carlos Iguina
USS Topeka (SSN 754)

Lt. j.g. Michael Joiner
USS Tucson (SSN 770)

Lt. j.g. Christopher Jones
USS Topeka (SSN 754)

Lt. j.g. Alfred Keller
USS Alabama (SSBN 731) (B)

Lt. j.g. Kristopher Kellogg
USS Olympia (SSN 717)

Lt. j.g. Alexander Kikilas
USS Michigan (SSGN 727) (B)

Lt. j.g. Thomas Manemeit
USS Oklahoma City (SSN 723)

Lt. j.g. Brian Maxfield
USS Buffalo (SSN 715)

Lt. j.g. Nicholas Miller
USS Louisville (SSN 724)

Lt. j.g. Dustin League
USS North Carolina (SSN 777)

Lt. j.g. Stephen Leff
USS Tucson (SSN 770)

Lt. j.g. Andrew Lingenfelter
USS Santa Fe (SSN 763)

Lt. j.g. Anthony Malon
USS Henry M. Jackson (SSBN 730) (B)

Lt. j.g. Forest McLaughlin
USS Louisiana (SSBN 743) (B)

Lt. j.g. Lawrence Overway
USS Ohio (SSGN 726) (G)

Lt. j.g. Arlis Steel
USS Michigan (SSGN 727) (G)

Lt. j.g. Henry Tran
USS Nevada (SSBN 733) (B)

Lt. j.g. Judson Thomas
USS Jacksonville (SSN 699)

Line Officer Qualified in Submarines

Lt. Aaron N. Aaron
COMUSNAVEUR COMSIXTHFLT
Det Naples Sea Comp

Lt. James Bonner
USS Key West (SSN 722)

Lt. David Hayashida
USS Key West (SSN 722)

Lt. Joshua Nickerson
USS Henry M. Jackson (SSBN 730) (B)

Lt. Brian Re
USS Kentucky (SSBN 737)

Lt. j.g. Nicholas J. Anderson
USS Springfield (SSN 761)

Lt. j.g. Jonathan W. Blair
USS Dallas (SSN 700)

Lt. j.g. Daniel J. Branchal
USS Georgia (SSGN 729) (B)

New British Sub Conducting Sea Trials in American Waters

Britain's first new nuclear attack submarine in more than two decades, HMS *Astute*, is conducting sea trials in North American waters. After loading Tomahawk Land Attack Missiles (TLAMs) at Naval Submarine Base Kings Bay, Ga., *Astute* conducted her first Tomahawk launch in mid-November, firing two TLAMs from the Gulf of Mexico onto a missile range at Eglin Air Force Base, Fla.

Britain is the only other country that operates TLAMs. The Royal Navy has operated the missiles since 1999 and has launched them from various submarines to support operations in Afghanistan, Iraq and, most recently, Libya, against which HMS *Triumph* launched Tomahawks during Operation Odyssey Dawn.

Astute will continue her trials in North American waters until early this spring, when she will return to the U.K. to train for her first operational deployment.



HMS *Astute* during a late-November port visit to Naval Station Norfolk.

Photo by Petty Officer 1st Class Todd A. Schaffer



Photo by Petty Officer 1st Class Virginia K. Schaefer



Photo by Petty Officer 2nd Class Ronald Gutridge

(Left) (left to right) Capt. Michael Holland, Rear Adm. Rick Breckenridge, and Capt. Michael Bernacchi at the change-of-command ceremony where SUBRON 2 was formally disestablished. (Right) Capt. James Childs (right) salutes Rear Adm. Frank Caldwell, Commander, Submarine Force, Pacific, at the ceremony where Childs assumed command of SUBRON 1 and SUBRON 3 was disestablished.

Submarine Squadrons Two and Three Disestablished

The Navy disestablished two submarine squadrons this winter as part of its drive to reduce shore structure and free up personnel for sea duty.

Groton-based Submarine Squadron Two (SUBRON 2) was disestablished in a Jan. 13 ceremony at Naval Submarine Base New London attended by U.S. Rep. Joe Courtney. Since its establishment in October 1945, following the end of World War II, SUBRON 2 has had nearly 100 submarines assigned to it, including USS *Nautilus* (SSN 571) and *NR-1*, the Navy's only nuclear-powered deep-submersible research vessel.

SUBRON 2's boats have been reassigned to Submarine Development Squadron Twelve with the exception of USS *Springfield* (SSN 761), which has been reassigned to Submarine Squadron Four. SUBRON 2's outgoing commodore, Capt. Mike Holland, assumed command of SUBRON 4, relieving Capt. Mike Bernacchi, who will serve as chief of staff for Commander, Submarine Group Two.

The disestablishment of Pearl Harbor-based Submarine Squadron Three (SUBRON 3) took place Feb. 2, during a ceremony in which SUBRON 3's outgoing commodore, Capt. James Childs, assumed command of Submarine Squadron One, relieving Capt. Stanley Robertson.

SUBRON 3 was formed in November 1930 in the Panama Canal Zone, where it remained until the end of World War II, by which time it included only the rescue vessel USS *Mallard* (AM 44) and three destroyers. The squadron was reestablished at Guam in October 1945 and moved to San Diego in early 1946. It was deactivated in 1995 but then reactivated at Pearl Harbor in June of 1997.

SUBRON 1 has assumed responsibility for three of SUBRON 3's former boats, and two others have been reassigned to Pearl Harbor-based Submarine Squadron Seven. The remaining boat, USS *Chicago* (SSN 721), is slated to join Submarine Squadron Fifteen at Guam.

Lt. j.g. Nicholas Clendenning
USS Connecticut (SSN 22)

Lt. j.g. Tyler Coats
USS Henry M. Jackson (SSBN 730) (G)

Lt. j.g. Brandon Comer
USS Jefferson City (SSN 759)

Lt. j.g. Kurtis Daniels
USS Nevada (SSBN 733) (B)

Lt. j.g. Brian Davis
USS Topeka (SSN 754)

Lt. j.g. Jerome Ennels
USS Nevada (SSBN 733) (B)

Lt. j.g. Jason A. Evert
USS Springfield (SSN 761)

Lt. j.g. Jacob Hanft
USS Charlotte (SSN 766)

Lt. j.g. John Hayashi
USS Asheville (SSN 758)

Lt. j.g. Juan Huizar
USS Asheville (SSN 758)

Lt. j.g. Matthew C. Japzon
USS Georgia (SSGN 729) (B)

Lt. j.g. Christopher Jessel
USS Cheyenne (SSN 773)

Lt. j.g. James Kaufman
USS Maine (SSBN 741) (B)

Lt. j.g. Aaron C. Kemper
USS Alaska (SSBN 732) (B)

Lt. j.g. Travis King
USS Michigan (SSGN 727) (B)

Lt. j.g. Benjamin Kohn
USS Maine (SSBN 741) (B)

Lt. j.g. Kristopher Lewis
USS Nevada (SSBN 733) (B)

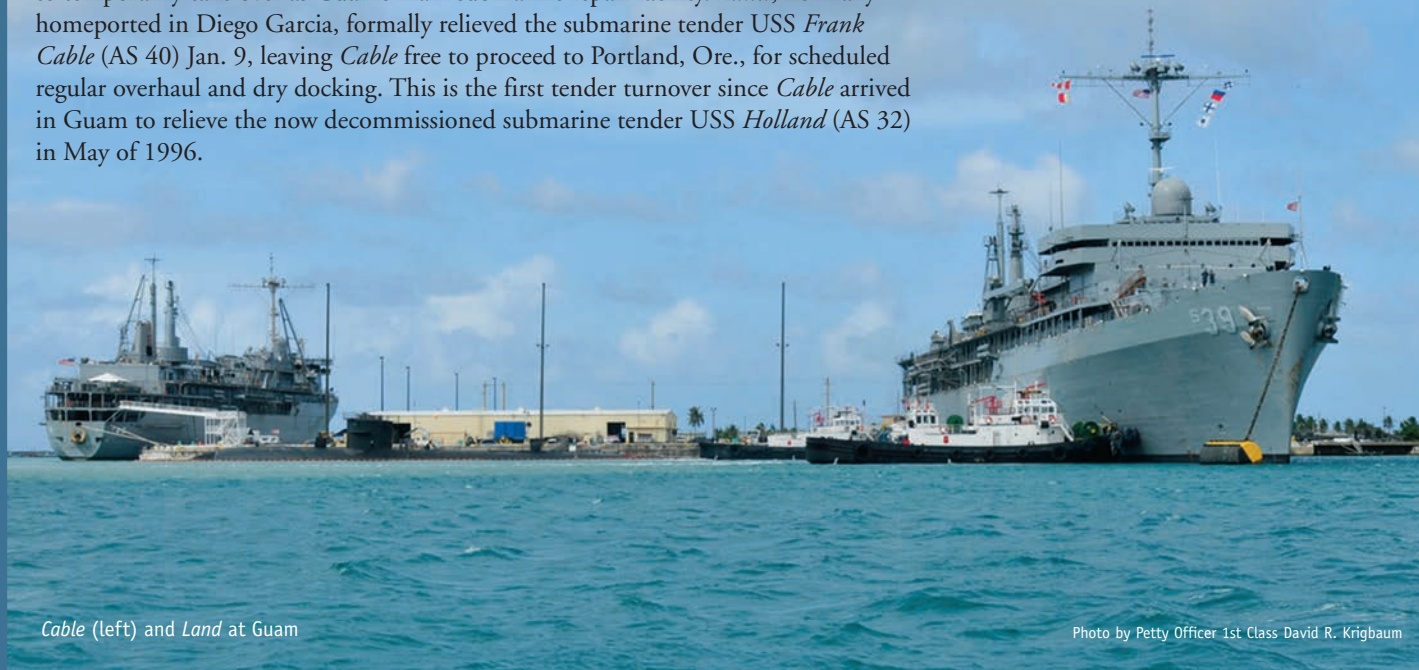
Lt. j.g. Judd A. Lorson
USS Memphis (SSN 691)

Lt. j.g. Joseph Mabis
USS San Francisco (SSN 711)

Lt. j.g. Eric J. Macke
USS Annapolis (SSN 760)

Emory S. Land Relieves Frank Cable

Submarine tender USS *Emory S. Land* (AS 39) arrived at Naval Base Guam Nov. 21 to temporarily take over as Guam's main submarine repair facility. *Land*, normally homeported in Diego Garcia, formally relieved the submarine tender USS *Frank Cable* (AS 40) Jan. 9, leaving *Cable* free to proceed to Portland, Ore., for scheduled regular overhaul and dry docking. This is the first tender turnover since *Cable* arrived in Guam to relieve the now decommissioned submarine tender USS *Holland* (AS 32) in May of 1996.



Cable (left) and *Land* at Guam

Photo by Petty Officer 1st Class David R. Krigbaum

Lt. j.g. Thomas Manemeit
USS Oklahoma City (SSN 723)

Lt. j.g. Francisco Martinez
USS Kentucky (SSBN 737)

Lt. j.g. Dillan Masellas
USS Maine (SSBN 741) (B)

Lt. j.g. Ryan McCabe
USS Cheyenne (SSN 773)

Lt. j.g. George McColgan
USS Miami (SSN 755)

Lt. j.g. Ian Miller
USS Miami (SSN 755)

Lt. j.g. Richard Mongold
USS Alabama (SSBN 731) (G)

Lt. j.g. Anthony Nebel
USS Seawolf (SSN 21)

Lt. j.g. Ross Newman
USS Albuquerque (SSN 706)

Lt. j.g. Shane T. Odell
USS Pittsburgh (SSN 720)

Lt. j.g. Peter A. Ozug
USS Alaska (SSBN 732) (B)

Lt. j.g. Jonathan M. Perkins
USS Springfield (SSN 761)

Lt. j.g. Anthony Ray
USS Buffalo (SSN 715)

Lt. j.g. Matthew S. Reising
USS Alexandria (SSN 757)

Lt. j.g. Alex Rinaldi
USS Montpelier (SSN 765)

Lt. j.g. Dominic Rinaldi
USS La Jolla (SSN 701)

Lt. j.g. Jonathan Rogan
USS Michigan (SSGN 727) (B)

Lt. j.g. David Schwarzbart
USS Louisiana (SSBN 743) (G)

Lt. j.g. Kyle Scribner
USS Maine (SSBN 741) (G)

Lt. j.g. Michael Seipp
USS Kentucky (SSBN 737)

Lt. j.g. Andrew Shafer
USS Columbus (SSN 762)

Lt. j.g. Tomas Simonson
USS Henry M. Jackson (SSBN 730) (G)

Lt. j.g. Daniel Shofner
USS Alabama (SSBN 731) (G)

Lt. j.g. Jonathan D. Skates
USS Georgia (SSGN 729) (B)

Lt. j.g. Aaron R. Stomski
USS Virginia (SSN 774)

Lt. j.g. Nicholas Swanda
USS San Francisco (SSN 711)

Lt. j.g. Nicholas Takeuchi
USS Nebraska (SSBN 739) (B)

Lt. j.g. Waley E. Tolba
USS Pasadena (SSN 752)

Lt. j.g. Edward C. Watters IV
USS Georgia (SSGN 729) (B)

Lt. j.g. Nicholas A. Woodcock
USS Toledo (SSN 769)

Limited Duty Officer Qualified in Submarines

Ensign Justus Steckman
USS Jimmy Carter (SSN 23)

Supply Officer Qualified in Submarines

Lt. Anthony Williams
USS Georgia (SSGN 729) (G)

Lt. j.g. Nicholas A. Crowell
USS San Juan (SSN 751)

Lt. j.g. Michael Dausen
USS Tucson (SSN 770)

Lt. j.g. Bryan Martinez
USS Asheville (SSN 758)

Lt. j.g. Curk W. Zining
USS Alexandria (SSN 757)

Ensign David Dyal
USS Hartford (SSN 768)

Special Recognition – Battle “E” Winners

USS Buffalo (SSN 715)

USS Olympia (SSN 717)

USS Providence (SSN 719)

USS Michigan (SSBN 727) (B)

USS Florida (SSGN 728) (B)

USS Florida (SSGN 728) (G)

USS Alaska (SSBN 732) (B)

USS Alaska (SSBN 732) (G)

USS Nebraska (SSBN 739) (B)

USS Nebraska (SSBN 739) (G)

USS Newport News (SSN 750)

USS Annapolis (SSN 760)

USS Santa Fe (SSN 763)

USS Hampton (SSN 767)

USS Connecticut (SSN 722)

USS Texas (SSN 775)

USS New Hampshire (SSN 778)

USS Frank Cable (AS 40)

Floating Dry Dock Arco (ADRM-5)

Torpedo Weapons Retriever Devil Ray
(TWR 6)

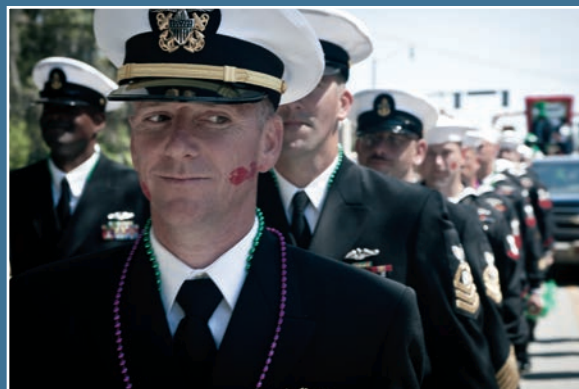


Naval Submarine League's 14th Annual Photo Contest

How do we look NOW?

Last year's winners showed our submarine community from very different perspectives. If you captured any images this good in 2011 or 2012, we'd like to see them!

Submit your submarine-related photos to
UNDERSEA WARFARE Magazine, which will publish
a selection of the best entries in the Fall 2012 issue.



CASH PRIZES for the TOP 4 PHOTOS

1ST Place
\$500

2ND Place
\$250

3RD Place
\$200

Honorable Mention
\$50

Submit all entries by May 30, 2012. Photos must be at least 5" by 7", at least 300 dots-per-inch (dpi) and previously unpublished in printed media. Limit of five submissions per person.

E-mail photos in JPG or other digital formats to underseawarfare@navy.mil, or mail printed photos to:

Military Editor
Undersea Warfare CNO N97
2000 Navy Pentagon
Washington, D.C. 20350-2000



Submarine Museums and Memorials



Forward
torpedo room.

Historic Ships in Baltimore photo



Torsk
at pier side.

Historic Ships in Baltimore photo

USS *Torsk* Memorial and Museum

Baltimore, Maryland

Docked at a pier in Baltimore, Md., USS *Torsk* (SS 423) is one of only two *Tench*-class fleet submarines remaining in the United States—and the last boat to torpedo an enemy ship in World War II.

On Aug. 14, 1945, while on her second war patrol, *Torsk* used advanced acoustic torpedoes to sink two small Japanese escort ships in the Sea of Japan. She sank the first warship, which was escorting a cargo vessel, with the new experimental Mark 28 torpedo. A few hours later, another small escort ship arrived on the scene, and *Torsk* launched a second Mark 28.

Observing that the enemy had spotted her, the submarine hurriedly dove to 400 feet. She then released a smaller Mark 27 torpedo, known as a “Cutie,” which was specially designed to let a submarine at depth strike an enemy warship overhead. Almost immediately, the crew heard a loud explosion as the Mark 28 found its mark. A second explosion—probably the Cutie—was followed by loud breaking-up noises. The next day, Aug. 15, the “cease fire” order went out to all U.S. forces.

Following the war, *Torsk* was based at Naval Submarine Base New London, in Groton, Conn. Serving as a training boat for the Naval Submarine School, she made several dives per day and soon

became the “divingest” submarine in the Navy. By the time she was decommissioned, she had logged an unrivaled 11,884 dives.

In June 1949, *Torsk* returned to her birthplace, Portsmouth Naval Shipyard, in Kittery, Maine, for what was called a “fleet snorkel conversion.” Among other things, the conversion gave her a streamlined sail to house the snorkel intake and exhaust masts as well as her periscopes and radar and radio antennas.

In the 1950s, *Torsk* served for some time as a guidance boat for the first-generation Regulus I cruise missile, positioning herself along the missile’s flight path to help control its flight. *Torsk* later received the Presidential Unit Citation for operations in the Mediterranean during the 1960 Lebanon Crisis and the Navy Commendation Medal for assisting in the blockade of Cuba during the 1962 Cuban Missile Crisis.

Decommissioned in March 1968, she was transferred to the State of Maryland in 1972 and opened as the Maryland Submarine Memorial on May 1, 1973. *Torsk* is part of a collection of historic American ships in Baltimore’s Inner Harbor that also includes the sloop-of-war *Constellation*, the Coast Guard Cutter *Taney*, and the lightship *Chesapeake*.

www.historicships.org/torsk.html